

SCIENTIFIC REPORTS
OF THE
INDIAN AGRICULTURAL RESEARCH INSTITUTE
FOR THE YEAR ENDED 30TH JUNE 1952



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PART I

REPORT OF THE DIRECTOR

Besides the normal activities of post-graduate training and research, the Indian Agricultural Research Institute, New Delhi, has taken on the additional responsibilities of undergraduate teaching in agriculture and extension work in the villages from the beginning of the year under report. The Central College of Agriculture was integrated with this Institute from 1st July, 1951 and as a measure of economy, the full complement of the original college staff was not sanctioned and some of the expert staff of the Indian Agricultural Research Institute assist in the teaching of the Central College of Agriculture in addition to their other work.

Some of the results of research done at the Institute has been actually demonstrated in the cultivators' fields in villages around Delhi. Two of the new Pusa wheats, e.g., N.P. 718 and N.P. 775, have been accepted as superior to the existing locally grown varieties and about 125 acres of land have been covered by these wheats in Delhi villages. Improved varieties of peas, oats and other crops have also been distributed to cultivators. The land army units of the Institute consisting of staff and students have done useful work in the villages by digging compost pits, planting fruit trees, removing weeds from crop fields, and by helping to control diseases and pests of cultivated crops.

A six weeks' training course in mechanised agriculture for the benefit of officers from the various states was organised with the help of Mr. Earl K. Rambo, a U.S. expert. Besides ploughing with different types of tractors, full training in theory and practical uses of a large number of agricultural implements were given. The utility of some Japanese machines in agriculture and their labour-saving value was shown, and some modifications to suit Indian conditions have been made.

A useful and effective seed drill for jute seeds has been produced in the Agricultural Engineering Division and this is likely to solve a long felt need for the jute growing areas and would indirectly help in saving large quantities of seeds which are usually wasted in the broadcast method of sowing.

The Institute continued to give expert advice to the Union Ministry of Food and Agriculture and various State Governments. Members of the Institute staff attended a number of scientific meetings and conferences. Besides the normal research projects of the Institute, 18 other research projects sanctioned by the Indian Council of Agricultural Research, Indian Central Oilseeds Committee and Indian Central Sugarcane Committee were in progress during the year. These include the preparation of a monograph on the practice and methods of agriculture in ancient India.

Dr. B. P. Pal continued as Director throughout the year. Shri R. Venkata Ramiah, Head of the Division of Agricultural Engineering, was away in the U.S.A. under the Fulbright scheme from 27th September, 1951 to 16th April, 1952. Shri C. P. Srivastava acted in place of Shri Ramiah during his absence in the U.S.A. Dr. S. V. Desai, Soil Microbiologist, was deputed to the Rajasthan Government from 6th November, 1951. Dr. A. R. S. Kartha joined as Assistant Organic Chemist on 14th December, 1951. Dr. S. P. Raychaudhury, Assistant Virologist was on study leave in the U.S.A., and Dr. M. L. Gattani, Assistant Plant Pathologist, was on deputation in Rajasthan throughout the year. Dr. R. P. Chaudhury, Assistant Insect Epidemiologist, left the Institute on 16th August, 1951 and joined the Central Potato Research Institute at Patna. Shri T. V. Venkataraman of the Entomology Division left for Australia for training under the Colombo Plan. Two senior posts of Wheat Breeder and Mycologist under the Co-ordinated Wheat Rust Control Scheme were filled up in February, 1952 by the appointment of Dr. G. S. Murty and Dr. R. Prasada respectively.

A summary of salient points of research work done in the various Divisions is given in the following pages. This is followed by detailed reports of the six Divisions. The appendices give information regarding successful students, research staff and publications of the Institute.

SUMMARY OF MAIN RESULTS OF RESEARCH AGRONOMY

Manures and fertilizers :

Nitrogenous manures and fertilizers : Ammonium sulphate, ammonium nitrate, sodium nitrate and urea tried in different doses on wheat were found to be equally effective. In a comparison of sulphate of ammonia, cake and farm-yard manure (F.Y.M.) at different levels of nitrogen on wheat, groundnut cake at 80 lbs. N/acre gave the highest yield. No residual effect of the above manures on a subsequent crop of maize was noticed. In yield of maize 0, 40 and 80 lbs. N/acre as ammonium sulphate differed significantly from one another. Super-phosphate at 40 and 80 lbs. P_2O_5 /acre did not differ significantly between themselves but both were superior to 'no phosphate' treatment. The same effects were noticed in the wheat crop taken to study the residual effect.

40, 80 and 120 lbs. N/acre as ammonium sulphate, significantly increased the yield of potato tubers. Superphosphate at 30, 60 and 90 lbs. P_2O_5 /acre had no effect. Placement of fertilizers did not show any advantage over fertilizer distributed by broadcast.

Manuring of paddy in the nursery with different forms of nitrogenous fertilizers was found to be beneficial. F.Y.M. and ammonium sulphate to supply nitrogen in equal proportions were both superior to ammonium sulphate in this respect.

Green Manures : The effects of different *rabi* legumes grown with and without phosphates and buried as green manures, on the subsequent crop of maize were not significant. No effect of phosphate was noticed. Sannhemp buried as green manure after 8 weeks growth gave the highest yield. Superphosphate at 80 lbs. P_2O_5 /acre at sowing, plus 15 lbs. N/acre as ammonium sulphate at time of burying sannhemp had the least effect. At Karnal, sannhemp as green manure was found to be superior to *meth* but there was no significant difference between sann, cowpeas and *guar*.

Phosphatic fertilizers on legumes : Ammophos at 160 lbs. P_2O_5 /acre or the combination of ammonium sulphate with superphosphate to supply as much nitrogen and P_2O_5 as in ammophos, gave the highest yield of berseem fertilized with phosphates, and showed that while in cowpeas the differences in yield due to treatments to berseem were not significant, those for wheat were significant. The highest dose (64 lbs.) of P_2O_5 /acre used, either in the form of super or F.Y.M. or their combinations gave the best yield. Residual effect of phosphate-manured berseem on maize and wheat was compared with direct manuring of the above crops. The differences in yield showing that treatment of berseem with N40 and P120 did build up soil fertility equivalent to 40 lbs. N/acre as ammonium sulphate.

In a paddy-berseem rotation, berseem gave significantly superior yield when phosphate was applied either to berseem or to the previous crop of paddy.

Micronutrients : Boron and molybdenum with and without phosphate were found to significantly increase the fodder and seed yield of berseem. In yield of maize and wheat, taken to study the residual effects after two crops of berseem, the micronutrients were also significant.

Different micronutrients were tried on rape, oats, tobacco, maize and *jowar*. The yields due to micronutrients differed significantly only in the case of *jowar*, where iron and magnesium treatments were superior to all other treatments. In other crops also, iron spray gave the highest yields though the yield differences amongst treatments were not significant.

Cultural Experiments :

In a rotation of maize-berseem-fallow-wheat on clay loam soil, country ploughing proved to be just as good as tractor ploughing followed by tractor disc or Victory ploughing followed by country ploughing and was superior to tractor discing alone.

In yield of maize there was no difference between 2, 4 or 6 ploughings, while 3 hoeings were better than 1 or 2 hoeings. In method of applying fertilizers the best treatment was ploughsole placement.

Placement of fertilizers at $2\frac{1}{2}$ " below the surface was significantly superior to broadcast or placement at $4\frac{1}{2}$ " below the surface.

In wheat, nine and twelve ploughings were significantly superior to 6 or 3 ploughings but there was no difference, however, between nine and twelve. 6 ploughings were found to be superior to three.

In cotton, May and April sowings were significantly superior to June sowings. Differences in yield due to 2, $2\frac{1}{2}$ and 3 feet spacings were not significant.

Experiments on Rotations, small holdings and mixed cropping :

Experiments on different systems of rotations and six-acre small holdings under irrigated conditions were in progress. In mixed cropping experiments, maize and cowpeas for seed and jowar and cowpeas for fodder in the ratio of 1 : 1 showed the best performance.

Difference in yield of wheat from mixed cropping of wheat and gram in different proportions or in different modes of sowing were not significant.

Varietal-cum-manurial and varietal trials :

Wheat : In a trial of NP (4, 12, 80-5, 165, 710, 715, 718, 721, 760 and 765) and Punjab Wheats (C518, Pb.C.217, C591) NP 165 showed the best performance. C518 did almost equally well. Fertilizer mixture N20 P30 was significantly superior to 'no manure'.

Sugarcane : Out of the varieties Co 312, Co 647, Co 659, Co 712, Co 728 and Co 739 which were tried variety Co 647 outyielded others in cane tonnage. The nitrogen doses 40, 80 and 120 lbs./acre did not improve cane yield.

Linseed : Variety B 5128 was significantly superior to NP 21, Dakota flax and Sheyanne flax. The fertilizers did not evoke any response.

Tobacco : Hybrids S.19 and S.22 gave significantly higher yields than hybrids S.14 and S.20. There was no difference in yield between 'no manure' and 40 or 80 lbs. N/acre.

Rust resistant strains of linseed : RR 208 gave significantly higher yield than NP 21, RR 10, RR 191, RR 193, RR 197 and RR 238.

Sweet potato : Type FA 17 outyielded varieties B 219, T.S.T. white and FB 4004, *Sannhemp :* For green-manure purposes Kanpur 12 and U.P. 5-1 were equal and they both were superior to Assam 5-1, D13, UP5-2, D20, D11 B.O. 32-1. *Maize :* Pusa yellow No. 2 and Guntur were significantly superior to 'Nodak'.

Grasses and legumes :

Ley Farming : Unmanured maize and wheat crops were taken on one-year and two-year ley plots after the leys had been turned under. In yield of maize though not of wheat a cereal rotation served as control. *Cenchrus* mixture yielded significantly more than *Dichanthium* or Rhodes mixture or cereal rotation. In yield of maize in two-year ley treatments, 'two-year ley twice manured' treatment was superior to 'two-year ley once manured' or 'two-year ley-unmanured'. *Cenchrus* mixture proved superior also to other mixtures or cereal rotation.

In a study of root systems of grasses *Heteropogon contortus* and *Cenchrus ciliaris* were found to have maximum root development.

Kudzu Vine : Kudzu yielded about 447 mds. of green fodder/acre in three cuttings. Four crowns established during 1949 and which were transplanted in February 1950, flowered in September 1951 i.e., 17 months after transplantation. Agronomic treatments, e.g., defoliation, watering, and staking failed to induce flowering in the vine in the second year also.

Irrigation experiments :

In a study of the influence of depth of furrows on yield of potatoes, it was found that 6" deep furrows were superior to 4" or 9" deep furrows.

Three spray irrigations intensities (100 per cent, 75 per cent, and 50 per cent of the amount of water applied by surface irrigation) were compared with normal surface irrigation. There was no difference in yield of potato tubers among the four treatments.

Cattle breeding and management :

The strength of the herd at the close of the year was 51. Twenty-one cattle were transferred to the Cattle-cum-dairy Farm at Karnal in January, 1952. The wet and overall milk averages were 22.5 and 13.5 lbs. per cow per day respectively. The highest wet average recorded was 26.4 lbs. in the month of February, 1952. The average yields of milk obtained in various lactations were 5,852 lb. in first, 4,874 lb. in second, 6,748 lb. in third, 7,311 lb. in fourth, 6,618 lb. in fifth and 3,253 lb. in the sixth lactations. Out of 15 cows which completed their lactations, two gave over 8,000 lbs. per lactation. The mortality among the pail-fed calves was only 5 per cent. The growth rate for male calves was 1.34 lb./day and for female 1.08 lb./day. Two early maturity heifers completed their lactations. Four times milking, and milking cows before calving continued as a routine practice.

Permanent Manurial and Rotations experiments at Pusa :

Organic manures or green manure in conjunction with P205 gave the best yields.

Miscellaneous :

Cost of production of wheat, barley, oats, peas, gram, maize for grain and berseem, jowar and maize and cowpeas for fodder during 1949-50 was calculated. Cost of production of milk for 1949-50, 1950-51 and 1951-52 was also calculated. In attempts to get the maximum yield of a few crops the following were achieved : Maize 38-0 mds./acre, potato (*Phulwa*) 507 mds./acre, potato (*Simla Special*) 537.7 mds./acre and sugar-cane 784 mds./acre.

AGRICULTURAL SUB-STATION, KARNAL

Since the re-organisation of the agricultural sub-station at Karnal and the handing over of the major part of the area to the Cattle-cum-dairy Farm only 180 acres of land is at present for this Sub-station. This has resulted in lower receipts. As against a total receipts of Rs. 1,52,347 during 1950-51, the receipt for 1951-52 fell to Rs. 47,986, the loss being mainly due to the loss of income from the dairy which has gone over to the Cattle-cum-dairy Farm.

The sub-station carried on some manurial experiments on paddy. Manuring of paddy in a nursery with different forms of nitrogenous manures was found to be highly significant. It was found that farm-yard manure and a mixture of farm yard manure and ammonium sulphate in equal proportion were superior to ammonium sulphate alone. Among the doses of nitrogen, 60 lbs. nitrogen per acre gave the best yield of paddy.

In an experiment on green manuring it was found that sannhemp gave significantly higher yield of wheat than moth.

Varietal trials of wheat : Seven N.P. wheat varieties of the 700 series and seven other wheats were included in a trial for testing their respective yields. N.P.718 gave the highest yield which was followed by C 591 and N.P.720.

Linseed : Among the seven varieties of linseed, R.R.236 gave the best yield and R.R.197 was the second best.

Cultural experiments : Experiments on the merits of seed bed preparation with tractor plough and bullock drawn inversion and non-inversion ploughs were conducted but no significant differences were noticed.

Seed Supply : One of the important function of the sub-station is the multiplication of pedigree seeds. About 696 maunds of such seeds of various crops were distributed during the year.

AGRICULTURAL ENGINEERING

The research and other activities of the Division continued to be on a restricted scale due to the lack of proper workshop and office buildings which could not be built during this year. The Division has been also doing the work of servicing, repairs and maintenance of the machinery of other Divisions and maintenance and operation of farm and dairy machinery of the Division of Agronomy.

Trials of implements and machinery : (i) *Seed Drills* : (a) A single row planter, designed and developed by this Division was experimented upon, with maize seeds. The seeding was quite satisfactory but the land wheels were found to get clogged sometimes and so needed some modification. This drill is expected to be suitable for seeding groundnuts also. It would be tried more exhaustively after modifying the land wheels.

(b) An *argadha* of Madhya Pradesh has been converted into an automatic mechanical seed drill and tried with cow-pea seeds. The drill was found satisfactory, as with the minimum opening of the feed roller, it gave a seed rate of 8 seers per acre which could be increased upto 12 seers per acre. It takes 100 minutes to sow one acre of land.

(c) With a view to study the possibility of seeding paddy in rows by machines, a five-row British seed drill, workable by a pair of bullocks and adjusted to a seed rate of 48 lbs. per acre was tried on a well-prepared dry land at the Botanical Sub-station at Pusa (Bihar). The seeding was satisfactory.

(ii) *Rice-land Weeders* : Experiments on Japanese, one-and-two-row weeders were conducted at the Botanical Substation, Pusa (Bihar) and it was found that these were better than the '*khurpi*' for weeding in rice lands and were suitable for continuous work. Planting rice in rows is, however, a pre-requisite for use of this weeder which works successfully in fields that have been transplanted in rows with widths of 9 inches and over, in which there is standing water 1 to 2 inch deep. It can weed one acre of land in 5 hours. The weeder can not be used satisfactorily if the moisture in the field is below 20 percent.

(iii) *A Power Thresher for Paddy* : A power thresher for paddy has been developed in the Division on the model of the Japanese Pedal-operated Thresher and tried at the Agricultural Sub-station at Karnal. The output of the thresher was observed to be about 656 lbs. per hour. The cost of threshing was calculated as Rs. 0.31 per maund. The corresponding figures of the Japanese Pedal operated thresher are 80 lbs. hr and Rs. 0.50 per maund.

(iv) *Bund Former* : The trials with a bund former showed an output of 6,000 ft. long and 7 inches high bund per hour in a soil containing 1.50 percent of moisture. Output of the Victory plough for the same purpose is 3,000 ft. of the same height per hour. The draught in each case was about 200 lbs. in ploughed land.

(v) *Bakhars and Guntakas* : The indigenous blade harrows, known as *bakhars* and *guntakas* in Madhya Pradesh and South India respectively were subjected to field trials with a view to study their performance and suitability under different soil conditions. A *bakhar* of 15" width gave an output of 1.85 acres in 8 hours to a 4" depth and is considered capable of giving upto 2.50 acres in 8 hours. A *guntaka* having a blade 12" long and 2½" wide and adjusted to a depth of 4", gave an output of 0.20 acres per hour with a draught of 150 lbs. These implements work well on soft soil and are suitable for popularisation as implements for seed bed preparation.

(vi) *Plough Shares* : The plough shares, manufactured by an Indian firm were fitted with Delhi type bottom ploughs and tried. These were found to be satisfactory in use and of wear-resisting quality. The working life of the shares is about 3,000 hours, requiring one sharpening during the whole period.

(vii) *Bone Digester* : A bone-digester was designed and set up in this Division by Bawa Chetan Das of Banaras at the instance of the Ministry of Food and Agriculture for purposes of trial.

(viii) *Jute Seed Drill* : A seed drill for sowing jute seeds, has been designed and is under manufacture in the Division. This is expected to solve a long felt need of the cultivators.

BOTANY

Plant Breeding and Genetics :

Breeding for rust resistance in wheat was carried out at Delhi, Simla, Pusa and Indore. A large number of exotic varieties were studied for their rust reaction both under natural and artificial conditions of infection. A number of hybrid progenies in different generations including backcrosses and double crosses were raised under artificial conditions of infection and about 500 selections were made, based on their rust reaction and agronomic characters. These crosses also provided material for studies on the inheritance of reaction to rust and of other characters.

The hybridisation programme included about 50 new crosses and about 20 back and double-crosses.

In a performance test of one hundred newly evolved, rust resistant strains of linseed (*Linum usitatissimum*) conducted under conditions of artificial inoculation of linseed rust (*Melampsora lini*), seventy-five remained completely free from rust and, of these, thirty strains outyielded all the N.P. strains and the rust resistant strains evolved earlier at this Institute. These strains were, in addition, about 10-15 days earlier in maturity than all the other strains; promising strains among these will be sent to states like Madhya Bharat and Madhya Pradesh where early-maturing varieties are preferred.

Work on breeding of early-maturing, wilt-resistant strains of *rahar* (*Cajanus cajan*) was continued. The strains, C.15 W.E., C.15 Pusa, C.38 and D.16 were among those that gave the best yields in trials conducted at Delhi, Berhampur (W. Bengal), Sabour (Bihar) and Kanpur (U.P.); all of them had the additional advantage of being wilt resistant.

The pungent chilli types, N.P. 46A, N.P. 51, Hyb. 5-1-5, Hyb. 17-1-1 and 1402 (a selection, made in Madras State, from N.P. 46A) were among the best yielders in trials at Delhi, Pusa (Bihar), Hyderabad (Dn.) and Lam (Guntur—Madras State). R 449, a Russian non-pungent vegetable variety, gave the best yield at Delhi and Pusa (Bihar).

Nicotiana rustica selections, S 19, S 20 and S 22, recently bred at this Institute, which have a higher nicotine content than the other types under study, again gave the best performance; the yield data of this year's trial were, however, not found to be statistically significant.

A large number of indigenous and exotic varieties of tomato (*Lycopersicon esculentum*) were under study. In a comparative yield trial of two American varieties *Sioux* and *Prosperity*, Hybrid 3 (one of the early fruiting hybrids bred at this Institute) and *Desi Dickson* (a local selection), Hyb. 3 gave the best and *Sioux* the next best yield during the pre frost period (i.e., before mid-December). It appeared that, as regards overall performance, *Sioux* would be the top yielder, especially when winters are more or less frost-free. Also, *Desi Dickson* and *Sioux* proved to be the most suitable varieties for planting at different times of the year (July, August, December and February).

The work on maize included the study and performance trials of indigenous varieties and foreign maize hybrids. Besides, work on intensive inbreeding and determination of the combining abilities of the inbred lines was also in progress with a view to ultimately synthesising high yielding maize hybrids from material of Indian origin. *Pusa Yellow 2* is so far the best yielding indigenous variety. A number of foreign maize hybrids were under replicated trials at 14 centres in different states of India; *Dixie 11* was among the first five in seven of these trials. Good performance was also given by the hybrids, *Dixie 22*, *Dixie 33*, *Texas 26*, *N.C. 27*, *U.S. 13* and *Indiana 416B*. Five Canadian and four Australian hybrids were also tested for performance at seven centres; in general, the Australian hybrids yielded better than the Canadian ones.

Cytology and Cytogenetics :

Investigations were in progress on the utilisation of autopolyploidy in crop improvement. In the oil-yielding *toria* (*Brassica campestris* var. *toria*), there were clear indications that the "mass pedigree selection" method could further improve the fertility level of elite bulk populations of autotetraploids grown in isolation plots. An embryological study of these tetraploids revealed several types of abnormalities which were presumably responsible for their decreased seed-fertility. In linseed, further observations confirmed last year's findings that autotetraploids obtained from different diploid strains responded differently to polyploidy in the expression of gigantism or seed sterility.

In wheat (*Triticum* spp.) cytogenetical studies on a number of inter-specific hybrids and their amphiploids were in progress : the material included the major Indian species of cultivated wheat (*T. vulgare* and *T. durum*) and related species like *T. monococcum*/*T. dicoccum* and *T. timopheevi* which are known for their rust resistance. An analysis of the F_2 population of the pentaploid hybrid, *T. vulgare* × *T. pyramidale*, indicated a positive correlation between the number of chromosomes of the C genome and the likeness of the F_2 segregates to *T. vulgare* in respect of a number of ear characters.

Crop Physiology :

Studies on the physiological analysis of yield indicated that varietal differences in the contribution to grain from photosynthesis in the ear were largely accounted for by the presence of awns and by variation in spikelet number. The grain yield (of mother shoot only) was better correlated with grain setting than with the dry matter accumulated in the plant after anthesis, provided the whole photosynthetic surface (leaf, ear and stem) was intact and functioned normally, as such, differences in yield due to environment and/or variety may be associated with factors other than the amount of dry matter assimilated.

With regard to differences in the uptake of nitrogen, it was again confirmed that wheat N.P. 710 absorbed more nitrogen than N.P. 52 or N.P. 165, although there was little difference in the grain yield.

Evidence of differential response of varieties to indoleacetic acid and 2, 4-D was again obtained in wheat. The troublesome weed *Carthamus oxyacantha* (pohli) which is common in wheat fields, was found to be most susceptible to 2, 4-D at the age of about 9 weeks.

In a study on the lodging in wheat, indication was obtained that lodging was considerably reduced as a result of application of nitrogen ten weeks after sowing.

Systematic Botany and Plant Introduction :

During this year, 1,335 samples of seeds belonging to varieties of various crop plants and their related species were received from foreign countries ; 457 seed samples were sent to different experimental stations in India and abroad.

In further trials of sweet potatoes, the two Chinese varieties F.A. 17 White and *Tie Shin Tun*, gave tuber yields of 395 & 225 maunds, respectively, per acre as against about 140 maunds given by the best among the local types. There was a great demand for cuttings of these varieties ; these were supplied to growers in Delhi, Rajasthan, U.P., Punjab and PEPSU. An American variety of sweet potato i.e., Golden Skin Yam, was found to have 42.8 p.p.m. of carotene content as against 0 to 3 p.p.m. in all the other varieties under study.

The most promising introductions included : (i) some East African varieties of Italian millet (*Setaria italica*) one of which gave about 45 percent more yield than the local types in Himachal Pradesh, (ii) *Early Badger* and *Delwiche Commando*—two American varieties of garden pea, (iii) some sugarbeet varieties with high sugar content (15 to 16 percent), (iv) an Australian species (*Vicia sinkiangensis*) and a Cyprus variety of vetch (*Vicia sativa*), (v) a Ceylonese variety of *Indigofera endecaphylla* which was found to be useful for soil conservation and (vi) a creeping perennial grass (*Bothriochloa insculpta*) from Brazil which, in nutritive value, compares favourably with Rhodes grass and appears to be a promising pasture grass.

In a preliminary trial at Delhi, some jute varieties grew to a good height and gave very much higher yields than those obtained in areas where jute is grown for commerce.

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Manures & Fertilizers :

Studies on the effect of manures and fertilizers were continued. The manurial value of dicalcium phosphate prepared from rock phosphate and hydrochloric acid (by the National Chemical Laboratory, Poona) was compared with that of superphosphate. In experiments conducted in pots, the former gave higher yield of wheat grain than the latter. Experiments were also conducted on the utilization of certain waste materials, such, as tannery and slaughter house waste and wool and hair, which are known to have high nitrogen content, as manures. These materials when properly processed, gave encouraging results. Studies on the use of wild legumes as manures were continued. Experiments on the pretreatment of seeds by soaking in various nutrient solutions, milk and in decoction of certain medicinal plants were conducted. Presoaking in ammonium phosphate alone gave a somewhat beneficial effect.

Soil Fertility :

In lysimeters and in field experiments, the introduction of unmanured berseem in the rotation gave more than double the yield of the succeeding crop as compared to that of the unmanured cereal rotation of wheat and *bajra*. The soil of the plots, with a berseem rotation, followed for ten years, showed that phosphate-treated berseem plots contained higher amount of organic matter, organic nitrogen and also had higher ammonifying, nitrifying and nitrogen-fixing powers.

Studies on the inter-relationship between major inorganic elements showed that the cation/anion ratio of major elements in all seeds tended to remain constant (about 0.2) irrespective of species. This ratio while varying at different stages of growth, tended to remain constant at each stage of growth of a particular species and was correlated with the changes in the pH of plant sap.

Micronutrients :

The results obtained during this year confirmed the previous results that 'top yellowing' of gram was due to air water unbalance in the root-zone of the crop. Under these conditions there was greater absorption of iron and less uptake of manganese.

Pot culture experiments were conducted with *Phalaris minor* to study the uptake of micronutrients under different fertilizer treatments (superphosphate, ammonium sulphate, lime and muriate of potash). In the first cutting, both ammonium sulphate and super influenced higher absorption of copper while cobalt uptake was increased in all the cases. Manganese uptake, on the other hand, was depressed both by ammonium sulphate and superphosphate. No significant variation in the uptake was observed in the second cutting.

At Hosakottay, Coorg, the application of F.Y.M. and artificials including micro-nutrients to the soil of diseased citrus orchard* resulted in trees becoming green and putting up of new shoots and bearing of fruits. These trees did not bear any fruit for several years.

Soil Survey :

The study of the genetical relationship in a number of profiles collected in Bhopal showed that the brown layer frequently occurring in the B-horizon of the *regur* or black cotton soil profiles and the red-brown soil occurring frequently with the red soil are genetically of the same origin. The brown layer of red soils is more weathered and advanced in maturity.

Reconnaissance soil survey was carried out in the area commanded by the Chambal Hydel Project as well as in the *Bhangar* area of the Delhi State. Studies on the saline and alkaline soils of the Delhi State were continued. It was observed that a classification of the soils could be made on the basis of the degree of alkalisation.

Soil colloids and clay minerals :

Studies on the electrochemical and mineralogical properties of hydrogen clays prepared from soils at different depths of typical profiles from different localities of India for gaining information on the development and genesis of these soils were continued. The clay fraction of saline soil from Lucknow in *usar* tracts was found to be a mixture of kaolinite and illite. The clay fraction of the saline soil from Delhi (*Madanpur Khadar*) had a similar composition. Montmorillonite was the main constituent of the clay of the black *kanhar* soil from Labhandi, Madhya Pradesh. A black cotton soil profile from Bhopal, the upper horizon of which to a depth of 250 inches was black in colour and red below was found to have its clay fraction predominantly montmorillonite with no variation even in red horizon.

Buffer curves prepared from some soils (and in some cases for their clay separates also) were found to be typical and characteristic of the predominant clay minerals. The curves showed sharp inflections at pH 4.6 and 9.8. The buffer value was different and this property is attributed to the nature of clay mineral present.

The clays from the surface and sub-surface soils of Rann of Cutch were found to consist mainly of illite. The mineralogical examination of the fine sand fraction of black soils from Padegaon, Bhopal, Coimbatore and Koilpatti showed a common occurrence of a group of minerals namely pyroxene, hornblende, garnet and hypersthene which belong to basic rocks of South India. The associated red brown soils of Padegaon and Bhopal appear to have resulted from prolonged weathering of basalt.

Oils and Fats :

Attempts were made to develop a method for the detection of adulteration of ghee. The presence of hydrogenated fat in buffalo or cow ghee could be detected when present in the proportion of 5 parts per 100 parts of clarified butter, by using the ethyl ester of tyrosine in a concentration of 0.005 per cent in the hydrogenated fat.

The rapid method described in the previous year has been modified for the determination of the iodine value of oil in oil seeds with fair accuracy using about 0.5 g. of seed sample.

Insecticides and Fungicides :

A rapid routine method for the estimation of nicotine in plant tissues and in insecticides using absorption spectrophotometry has been developed. This method enables determination of one part per million parts with 2 per cent error. A method has also been evolved for the simultaneous production of terpene ethers and alcohols from Indian turpentine oil as a raw material.

Microbiological Studies :

Azotobacters were isolated from soils varying in pH from 3.7 to 8.6.

Results of experiments with inoculation of gram at different stations have shown that while method of seed inoculation is good for small seeds like berseem, lucerne, etc., it is not suitable for large seeds. In such cases inoculation of soil proved superior to inoculation of seeds.

Nutritive values of cereals and other foodstuffs :

Analysis of wheat grown with different manurial treatments in the permanent manurial and rotational experiments at Pusa (Bihar) showed that application of nitrogen alone increased the protein content of the grain. The ash and phosphorus content of the grain was also increased by the application of F.Y.M. as well as by P, PK, NPK and NP. The riboflavin content of the grains did not alter by such treatments as F.Y.M., rape cake, NPK, green manure and legume rotation. Different varieties of Indian wheat have been found to contain 0.8 to 1.01 μ g./g. of riboflavin and 33.4 to 46.2 μ g./g. of nicotonic acid.

Different varieties of tomato and sweet potato were found to contain 4.0 to 13.7 p.p.m. and 0 to 42.8 p.p.m. of carotene respectively. The content of ascorbic acid in these varieties of tomato varied from 28.2 to 72.4 mg. per 100 g.

Paper chromatographic method has been developed for the identification and estimation of amino-acids in food and feeding stuffs.

Mango seed kernel was found to be a good source of starch which compared well with maize starch in quality.

ENTOMOLOGY

Insect Parasitology :

Five research projects of fundamental nature were in progress during the year. The bionomics of *Lestodryinus pyrrillae* Kieff., a nymphal parasite of *Pyrrilla* spp. was worked out, *Pyrrilla* being a serious pest of sugarcane in Northern India. A marked sexual dimorphism was observed in the parasite. In the first pair of legs of the female the last tarsal segment is modified into a claw and of the two regular claws, one is enormously developed into a chelate claw. The females show a definite preference for 2nd, 3rd and 4th instar nymphs for parasitisation; 5-13 days after parasitisation the nymphs develop a bag like structure on the dorsum in between the wing pads. After 15 days the bag (thylacium) bursts out releasing the fully developed grub and the host dies. As a rule, only one grub emerges out from one host but sometimes two grubs emerge out from one bag. Sections of the dead host remain and the nymph with the developing grubs inside, showed that the grub feeds on the vital tissues and musculature in the thoracic region. The adult parasite emerges out after remaining in the pupal stage for about 20 days and lives for about 50 days. A hyperparasite was reared from the primary parasite.

Experiments were carried out to study the host preference of *Trichogramma evanescens minutum* R. using eggs of *Chilo zonellus*, *Gnorimoschema operculella*, *Sitotroga cerealella* and *Heliothis obsoleta*. It was found that strains of *Trichogramma* bred on *Coryra* and *Gnorimoschema* prefer only *Gnorimoschema* eggs for parasitisation. The size and shape of the host have no significant effect on the selection of a particular host. The parasites bred on *Gnorimoschema* are far more robust and healthier than the parasites that are bred on other hosts. During studies on the effect of different temperatures and humidities on the longevity and fecundity of *Trichogramma*, the results obtained indicated that the parasites continuously bred at 68°F and different humidities (45 per cent, 65 per cent, 75 per cent and 75 per cent) live longer and lay a large number of eggs in comparison with those bred at 80°F and 75 per cent R.H. and then transferred to 68°F and the relative humidities mentioned above.

Taxonomic studies on Indian *Ichneumonidae* contributed materially to our knowledge of this important group of parasites. The subfamily *Ophioninae* was reclassified into 4 tribes, 40 genera and 168 species. *Metopiinae* and *Mesochorinae* were critically examined. During investigations on the parasites reared from San Jose Scale collected from Kashmir, 9 species belonging to 8 different genera were recorded as new to Indian region. It is interesting to note that certain genera reared this year from San Jose Scale had not been recorded so far in any part of the world as parasite on this scale insect. The observations on the developmental stages of *Ageniaspis* and *Aphelinus* showed that they are endoparasite and ectoparasite respectively. Two species of *Coccinellid* beetles belonging to two different genera were recorded for the first time in India as predating on San Jose scale.

Systematic Entomology :

In continuation of the previous work on the genitalia of *Bruchidae* (= *Lariidae*) the male and female genital characters of one more species *Bruchus albopubens* Pic., were studied. Morphological studies on the genitalia of *Anobiidae* and *Ptinidae* led to the tentative conclusion that the genital structures of *Ptinidae* are on the whole simpler than those of *Anobiidae*. A new accessory structure obviously meant to aid oviposition and boring was observed and described in *Scelio oviphagus* sp. n., parasitising eggs of *Hieroglyphus nigrореpletus* Bol. Also the detailed morphology of the new species was studied. A technique was evolved for accurate determination of the areas in insect body which come in contact with ground surface during locomotion. Studies on *Eusarcocoris ventralis* (*Pentatomidae*) revealed some new features in the genitalia of adult males and

females. Studies on *Pyrilla* spp., has shown that there exists in India only one species of *Pyrilla* viz. *P. perpusilla*. Also a new coloured variety was collected from the environs of Delhi. Studies on the permeability of insect cuticle to aqueous stains and their relationship to vulnerability indicated that besides normal abraided areas, unabraided areas in cuticle also exist and that these areas are variously distributed in insects of different types.

Insect Ecology & Toxicology :

The long term collection of bioclimatic data on the epidemiology of spotted bollworms of cotton was continued and statistical analysis of the data collected since 1942 was further carried out. Ecological studies on *Trichogramma* sp. for constructing its Biometer were in progress. The insect was reared under five controlled temperatures (12°, 18°, 25°, 30° and 35°C) and two humidities (35 per cent and 75 per cent). Ecological studies on *Heiroglyphus nigrorepletus* confirmed last year's results regarding the specificity of food, the harmful effect of daily watering on hatching of eggs and the adverse effect of low humidity (30 per cent). The loss of water from insect bodies under different physical environments was studied. It was shown that (a) in all the four species of insects studied, the loss of weight during any particular period was higher at the lower humidities than at higher humidities and (b) like loss in weight the percentage mortality during any particular period was inversely proportional to relative humidity. Investigations were carried out on effect of temperature on the susceptibility of insects to fumigation. For the first time the effect of temperature existing during the different stages of fumigation operation was studied. It involved investigations on (i) effect of prefumigation temperature under six combinations of fumigation and post-fumigation temperatures, (ii) the effect of fumigation temperature under sixteen combinations of prefumigation and postfumigation temperatures and (iii) the effect of post-fumigation temperature under twenty-two combinations of prefumigation and fumigation temperatures. The interaction between effects of temperatures existing during different stages of fumigation viz., prefumigation, during fumigation and post-fumigation periods were interpreted in the light of the data collected. Unless the effect is masked by interaction the temperature coefficient of fumigant action is positive for fumigation temperature and negative for post-fumigation temperature. Different modern insecticides were compared for their relative toxicity with three species of insect pests. The effect of dusting DDT, BHC and Toxaphene in pots containing 'phadka' (*Heiroglyphus nigrorepletus*) eggs on the hatching of these eggs was studied. Nine samples synthesized in the Chemistry Division were tested for their toxicity and compared with some allied modern insecticides. The order of toxicity determined with different test insects was (a) with *Tribolium castaneum*, as emulsion Parathion > Aldrin > Dieldrin > BHC > DDT = Chlordan, (b) with *Poecillocerus pictus*, BHC spray > BHC dust > Toxaphene dust > DDT spray = DDT dust, and (c) with Psocids, Aldrin > BHC = DDT. The I.C.A.R. Scheme on DDT and allied insecticides was in progress. Investigations were carried out on (a) effect of treating soil with DDT and BHC on the termites attacking wheat and sugarcane, (b) comparative toxicity of the modern insecticides against Indian insect pests, (c) persistence and phytotoxicity of modern insecticides and (d) effect of treating seeds with these insecticides on the viability of those seeds.

Insect Physiology :

The comparative susceptibility of some cereals to *Rhizopertha dominica* was studied and the order of susceptibility was found to be crushed wheat, jowar, wheat and barley. The effect of artificial food on the longevity of adults of *Sphaerophoria scutellaris* Fab., was under investigation.

MYCOLOGY & PLANT PATHOLOGY

Wheat :**Rust :**

(i) *Physiologic races* : Out of 104 collections of rusts of wheat and barley from different parts of India, it was found that races 21 and 42 of black rust, 20 and 63 of brown rust and 19 and A of yellow rust were predominant and widely distributed. Other races found were 24, 34 and 40 of the black, 106 and 108 of brown and races D and E of the yellow rust. Race 107 of brown rust was confined only to the Southern part of Peninsular India.

(ii) *Collateral hosts* : Two wild grasses, i.e., *Vulpia myuros* and *Briza minor* in Ootacamund (Nilgiris) were infected with races 4 and 6 of *Puccinia graminis avenae*. At the Indian Agricultural Research Institute, New Delhi, two grasses, *Bromus catharticus* and *B. japonicus* and a wild barley, *Hordeum murinum* were infected with race 19 of the yellow rust. 104 collections of rusts on wild grasses made from various altitudes of Southern Bombay, Madras, Mysore and Northern Travancore are being studied and identified. Besides, 31 species of imported grasses were tested for their susceptibility to wheat and oat rusts of which 9 proved susceptible to *Puccinia graminis tritici*, 3 to *P. triticea*, 12 to *P. glumarum* and 14 to *P. graminis avenae*. A total of 3,472 seedlings were tested for the above study.

Rust resistance tests were carried out with 31,149 plants of various wheat varieties, their crosses, and progenies and also with allied genera. In the seedling resistance tests, 3 exotic varieties and 2 selections proved resistant to all the 9 Indian races of black rust, 4 exotic varieties resistant to all the 8 races of brown rust and one exotic variety resistant to all ten races of yellow rust. In the adult resistance tests, 29 exotic and 9 Indian wheat varieties, 58 hybrids and 17 cultures belonging to allied genera were found resistant to a mixture of the 9 races of black rust; 43 exotic and 14 Indian varieties, 4 hybrids, 10 cultures belonging to allied genera, 41 cultures of Delhi hybrid selections, 6 cultures of new crosses and selection of F_1 , proved resistant to a mixture of 8 races of brown rust; 24 exotic and 6 Indian varieties, 3 hybrids and 8 cultures belonging to allied genera were found to be resistant to all the ten races of yellow rust.

Loose smut :

Out of 175 wheat varieties, 75 and 66 varieties remained free from infection when inoculated with a mixture of isolates $L_1 + L_2$ and L_3 respectively, whereas several susceptible varieties developed 80 to 100 per cent infection. Varieties Pb. 8A, Pb. C.591 and Pb. C.518 which are used as control showed 50, 73 and 67 per cent infection, respectively; 61 varieties which remained free from loose smut infection with all the three isolates seemed to be quite promising.

Foot rot :

Observations on the incidence of foot rot in wheat were made in a "date of sowing" experiment. It was found that in October-sowings when the maximum temperature was 99.1°F. the disease incidence in three varieties (N.P. 771, N.P. 710 and N.P. 165) varied from 60-80 per cent, whereas in November and December-sowings when the maximum temperatures were 87.1°F. and 75.1°F. respectively, the crop remained free from infection.

Tundu disease

Investigations on the bacterial disease called the *tundu* disease were continued by inoculating with pure cultures of the bacterium and by infecting the soil by the nematode galls. While inoculation with pure culture failed to produce the disease, 40 to

60 per cent infection was obtained by soil infection by galls. It was also observed that the disease appeared in a more severe form in October-sowings than in November-sowings which suggest that time of sowing of wheat is an important factor. Removal of galls by floatation in water in buckets or tubs is an effective simple measure for controlling the disease.

Black Chaff : In the wheat plots of the Botany Division 26 exotic varieties received from U.S.A. for breeding rust resistant varieties, showed symptoms of the bacterial black chaff or pseudo black chaff. A yellow bacterium isolated from the diseased wheat plants, closely resembles, in all its major characteristics, *Xanthomonas translucens* var. *undulosum*, the causal organism of black chaff. This is the first record of the disease in India and has been, apparently, introduced along with the imported seed as the pathogen is seed-borne.

Barley : Twenty-five barley varieties were tested for rust resistance. In the adult stage, six varieties proved resistant to a mixture of all the 9 races of black rust, and one variety to a mixture of 10 races of yellow rust.

Sugarcane :

Red rot : Out of 99 varieties of canes tested for resistance to red rot by the standard plug method, 20 reacted as resistant, 59 as moderately resistant and 11 were resistant to nodal infection. For the study of physiologic forms of red rot fungus, 32 isolates of *Colletotrichum falcatum* were tested. Recent isolates obtained from Co. 312, Co. 313, Co. 421 and Co. 453 from the epidemic areas of north Bihar, eastern U.P. and eastern Punjab proved to be of light, profusely sporing, virulent type.

Out of the 89 cane varieties tested at Karnal for their resistance to smut, 9 reacted as highly resistant and 11 as moderately resistant. In a similar test at Delhi with 99 varieties of newly released Co-canes only 19 proved to be highly resistant.

Gram : A species of *Pythium* closely resembling *P. ultimum* was found associated with pre-emergence seed rotting of gram. Pathogenicity tests with the local *Pythium* sp and *P. ultimum* gave 87 and 93 percent seed rotting respectively in sterilised soil.

Pigeon-pea : Out of 20 selected varieties of pigeon-pea tested for wilt resistance 4 remained free from infection and 4 showed slight infection. These are ND 41, C 15 W., C, 38-3-1, N.P. 69×P 48-A, D 16-17-2 W.E., D.419-2-4, P.1 and P.2.

Linseed : Out of 109 varieties of linseed tested for rust resistance against all the 4 Indian races of *Melampsora lini* 98 were found to be immune or resistant both in the seedling and in the adult stage.

Virus diseases :

The common sannhemp mosaic was found to have a thermal death point of 95-98°C, the dilution-end-point between 1 : 500,000 and 1 : 100,000 and longevity in vitro of 257 days at 6-10°C. A study of the host range showed that typical mosaic symptoms were produced on *Crotalaria striata* and *Phaseolus vulgaris*. On *Datura stramonium*, *Nicotiana glutinosa* and *Vigna sinensis* the virus produced local lesions while it was carried symptomlessly in *Lycopersicon esculentum*, *Solanum nigrum* and *S. nodiflorum*. No infection was obtained on *Dolichos lablab* or any of the several *Cucurbitaceous* hosts which were tested. Work on several other virus diseases like *phyllody* of toria *Sesamum*, *candytuft*, leaf curl of papaya and chillies, etc., were in progress.

Systematic Mycology :

Critical studies on *Cicinibolus cesati* and the status of its various synonyms were made. Glume blotch of wheat caused by *Septoria nodorum* was found to occur in India and has been described. Out of the 370 specimens collected during the year from various parts of the country about a dozen are new records for India and some are new species.

GENERAL FEATURES OF THE REPORT

Land and Buildings :

The residential hostel of the Central College of Agriculture was completed and formally opened by Maulana Abdul Kalam Azad, Union Minister for Education. Two glass houses, one in the Botany and the other in the Mycology Division, were completed. In view of the shortage of accommodation for the post-graduate students, Shri K. M. Munshi, Minister for Food and Agriculture, formally laid the foundation stone of another students hostel to be constructed in the near future. The additional land adjoining the Todapur village has been partly fenced. Further progress was made towards the building of the workshop of the Agricultural Engineering Division. A gymnasium for the C.C.A. students was also completed during the year.

Integration of C.C.A. :

The Central College of Agriculture was integrated with the Indian Agricultural Research Institute from 1st July, 1951. The post of Principal was abolished from that date and the seniormost Head of a Division holds charge of the post in addition to his duties for which he receives a special pay.

Post-graduate training :

The demand for more seats for post-graduate training of students continues to be heavy. During 1951-52 out of a total of 179 applicants only 45 students were admitted. 43 students completed their two-year course and were awarded the diplomas of this Institute. The Divisions to which they were attached are as follows :—

Agronomy 18 ; Botany 8 ; Chemistry 5 ; Entomology 6 ; Mycology 6.

Besides, a large number of research fellows, honorary research workers also worked in the Institute on various research projects. A short course on soil survey was also organised. Two students from the Punjab University who worked at this Institute obtained their M.Sc. degree.

Library :

The library of this Institute is one of the best Agricultural libraries in India and receives all the important journals dealing with agriculture and allied subjects. The total number of publications received during the year is 3,513. Twelve new periodicals were added during the year. 4,918 books were issued out on loan including 1,029 books which were sent out to scientific Institutes and research workers in the States. The reading room of the library which is kept open during the day and also in the evenings was utilised for consultation of journals and reference books by 9,362 persons.

During the period the library had to deal with a large number of enquiries and supplied references and bibliography of many specific items. Some of these may be mentioned below :—

1. List of literature on trace elements with particular reference to work done in India.
2. List of references on indigenous breeds of cattle in India.
3. List of books on bee keeping, poultry keeping and bakery science.

4. List of references on desert locust.
5. List of literature on hydroponics.
6. List of references on artificial rain-making.
7. List of literature on management and ecology of grass-land.
8. List of literature on Himalayas.
9. A brief note on vegetable indigo.
10. List of literature on desert reclamation.

Advisory work :

A large variety of enquiries has to be attended to by the Institute every year and in many cases expert advice has to be given to official and non-official sources. Some of these enquiries dealt with during the year may be mentioned below :—

Information was collected regarding standardising tyres of different tractors. Descriptions and illustrations of indigenous agricultural implements of India were prepared and sent to Belgian Embassy, New Delhi, for introducing these implements in Belgian Congo.

A sample of imported wheat received from the Ministry of Food was analysed and was found to contain a poisonous weed seed (*Lychnis githago*). Some desert plants collected in Rajasthan by a Russian Entomologist, Dr. Ivanhoff were identified. Botanical names of 25 desert plants were also supplied to the Soil Survey Officer, Hirakud Dam Project, Hirakud. Information regarding cultivation of camphor plant was given to Mr. R. S. Malik of Najafgarh Road, Delhi. Herbarium specimens of some wheat and allied species were prepared and sent to the Delhi University for teaching purposes. About 50 herbarium specimens of common weeds of cultivated fields and grasses were prepared and sent to Janta College, Alipore, Delhi.

A report on mapping and classification of Indian Soils was sent to the Food and Agriculture Organisation, Rome. A note on the manurial value and cost of production of compost was sent to the Extension Development Commissioner, Government of India. Information about different types of Indian Soils was sent to the Director of Agriculture, Bombay. A note on the vegetable indigo was prepared and sent to Messrs Donald Bros. Ltd. of Dundee, Scotland. 139 samples of bacterial cultures for inoculation of legumes seeds were supplied to various persons.

About 180 specimens of insects were distributed to various scientific Institutes of India and abroad, and about 380 specimens of insects received for identification have been duly identified. Information about stored grain pests was supplied to Mr. Bharmachari, Madras. The Agricultural Institute at Lashkar, Gwalior was supplied with the formula of insecticidal spray for the control of wooly-aphis. A total of 276 coloured plates of insect pests of crops were distributed to various correspondents in India.

RESEARCH SCHEMES

In addition to the usual research projects of the different Divisions, a number of research schemes financed by the Indian Council of Agricultural Research (I.C.A.R.).

the Indian Oilseeds Committee (I.C.O.C.), and the Indian Central Sugarcane Committee (I.C.S.C.) were in progress in the various Divisions of the Institute. They were as follows :—

No.	Title of the Scheme	Sponsored by	Division in which the work was in progress
1	Scheme for research on the cultivation of Kudzu vine	I. C. A. R.	Agronomy and Botany.
2	Scheme for the improvement of maize crop in India	Do.	Botany.
3	Plant Introduction Scheme	Do.	Botany.
4	Co-ordinated Wheat Rust Control Scheme	Do.	Botany & Mycology.
5	Scheme for research on minor trace elements	Do.	Chemistry.
6	Scheme for research on nitrogen fixation in soil	Do.	Chemistry.
7	Scheme for preparation of a monograph on agriculture in ancient India.	Do.	Chemistry.
8	Scheme for preparation of a monograph on phosphatic manuring ..	Do.	Chemistry.
9	Scheme for tests with DDT, 666 and allied insecticides	Do.	Chemistry and Entomology.
10	Bone meal scheme	Do.	Chemistry.
11	School of research in Entomology	Do.	Entomology.
12	School of research in Mycology (Physiology of parasitism) ..	Do.	Mycology.
13	Sugarcane disease scheme	I. C. S. C.	Mycology.
14	Linseed rust scheme	I. C. O. C.	Mycology.
15	Scheme for research in phyllody diseases of <i>Sesamum</i>	I. C. O. C.	Mycology.
16	Scheme for agronomical studies on oil seed plants	I. C. O. C.	Agronomy.
17	Scheme for cytological studies on some oil seed crops of India ..	I. C. O. C.	Botany.
18	Scheme for developing a method for determination of a small quantity of oil.	I. C. O. C.	Chemistry.

COLLECTIONS AND HERBARIA

Living plant collection :

Besides maintenance of a large number of varieties of crop plants, a large collection of wild relatives of these crops are also kept at the Institute. These form interesting and valuable breeding material and are exchanged with other Institutes.

The National Pusa Collection of named insects maintained at the Entomology Division is one of the three best collections in India, the other two being at the Indian Museum at Calcutta and the Forest Research Institute at Dehra Dun. During the year 1 genus and 4 species of *Lepidoptera*, 10 species of *Hymenoptera* and 3 species of *Coleoptera* not previously represented have been added to the National Pusa Collection. A catalogue of *Eumenidae* of the Oriental region was under preparation and a catalogue of *Bruchidae* of the same region has been completed.

The Division of Mycology maintains a special herbarium of fungi and during the year 134 specimens were added to the collection. The total number of specimens in this herbarium is now over 20,000. There is also a type culture collection in which as many as 862 cultures of fungi are maintained.

The Botany Division maintains a small herbarium of economic plants, weeds of cultivated fields and large living collection varieties of crop plants. The latter includes an all-India collection which is being maintained and described in collaboration with the F.A.O. World Catalogue Scheme. There is also a separate named collection of seeds, and a collection of living plants. During the year, 1355 samples of seeds were received from foreign countries by the Plant Introduction Section for trial in India. These included 12 samples of *Pyrethrum* from Japan and seeds of Oyster nut (*Telfaria pedata*) from Rhodesia. The creeping indigo from Ceylon continued to grow well and was found to be very suitable as a cover plant.

A collection of fodder grasses and legumes is maintained in the Agronomy Division. The collection contains a number of indigenous grasses whose performances are at present not much known outside. During the year 46 additions were made to this collection. Kudzu plants were in great demand and a total of 1450 crowns and 46 potted plants were supplied to various correspondents.

Intensive cultivation work in Delhi villages :

The work on the Intensive Cultivation Scheme in 19 villages of the Delhi State was continued. The work done during the year is summarised below.

A detailed survey of land crops, cattle, wells, timber trees, fruit trees, etc., of the Qamaruddin village was completed with a view to preparing an outline of the land transformation programme. In several villages, the cultivators have taken up the Pusa wheats known as N.P.718 and 775 for large scale cultivation and about 125 acres have been covered. Improved strains of some other crops also proved successful.

The Institute Land Army which included students and staff organised a campaign for the eradication of a trouble-some weed called *pohli* (*Carthamus oxacantha*) in Qamaruddin Nagar Village.

A survey of major insect pests of the villages was done and about 15½ acres of sugarcane crop was sprayed against the *Pyrilla* insect. In the Nilothi village about 200 fruit trees were treated against termite attack. Light traps were set up in some villages for controlling the *Kutra* moth (*Amsacta moorei*) and in ten villages about 7,000 rat holes were treated with cyanogen gas.

Meeting and Conferences :

As usual the Director, the Heads of Divisions and the other Class I officers of the Institute attended the meetings and conferences held during the year under the auspices of the various Ministries of the Government of India, the Indian Council of Agricultural Research, the various Commodity Committees, the Indian Council of Medical Research and other Official and Semi-official bodies either by virtue of their membership of the committees concerned or by special invitation. Mention may be made of the following attended by the Director :

Rice and Wheat Research Workers' Conference, First meeting of the Indian Council of Agricultural Education, meeting of the *ad hoc* Committee to consider the scheme for agronomic development of a rural area in Bengal (Viswa Bharathi).

Supply of pedigree seed and sale of cattle :

The demand for pedigree seeds produced at the I.A.R.I. continues to be very heavy. It was indeed impossible to meet the full demands in many cases. A comparative idea of the seeds distributed during the year and during 1950-51, is available from the following list :—

Crop									Quantity distributed in 1950-51	Quantity distributed in 1951-52
									Mds.	Mds.
Wheat	..	..	..	..	..	..	..	..	159½	860¾
Barley	..	..	..	..	..	..	..	..	22½	42½
Oat	..	..	..	..	..	..	..	..	25½	28½
Gram	..	..	..	..	..	..	..	..	14½	7½
Pea	..	..	..	..	..	..	..	..	24	22½
Lentil	..	..	..	..	..	..	..	..	16	½
Maize	..	..	..	..	..	..	..	..	9	22½
Potato	..	..	..	..	..	..	..	..	20½	10½

It will be observed from the above table that the demands for seeds of Pusa wheats were the highest and the quantity distributed, i.e., 860¾ mds. far exceeded the distributions made in the previous years.

The sale of cattle was severely restricted after the transference of the major portion of the herd to the Cattle-cum-Dairy Farm at Karnal. Only four cows and seven young bulls were sold by the Institute which fetched a total sum of 3,767.

Visitors :

Besides the high officials of the Ministry of Food and Agriculture and other Ministries of the Government of India, a large number of distinguished Indians and foreigners visited the Institute during the year under report of whom mention may be made of the following :—

Mrs. Eleanor Roosevelt (U.S.A.), Dr. C. V. Raman, F. R. S., General K. M. Cariappa, C.-in-C., Indian Army ; Dr. R. O. Whyte of Food and Agriculture Organization. Mr. M. R. Huberty of Food and Agriculture Organization, Mr. S. A. Clarke, Council of Scientific and Industrial Research Organization of Australia, Mr. J. P. Maule of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh, Messrs J. B. Howard, Paywood, F. Moyer and Dr. Douglas Ensmirger of Ford Foundation, Mr. C. W. Turner, University of Missouri, U.S.A., Prof. J. B. S. Haldane and Mrs. Haldane, U.K., Sir Ben Lockspeiser, Secretary, Department of Scientific and Industrial Research, London, Mr. A. P. J. Edwards, Department of Scientific and Industrial Research, London, Mr. Norman D. Cliff of News Chronicle, London, Messrs H. C. Lordheim, Kelly, Yeary and Dusanberry of the Technical Corporation Administration, Dr. Hitoshi Kihara, Kyoto University, Japan, Mr. Jaffar, Home Minister of Malayan State, the members of the Chinese Cultural Mission, Mr. N. H. Pooyani of Iranian Embassy, Dr. C. Van Dillewijn, Sugarcane Expert, Ceylon, Mr. Hajmadi, Member of the Board of Revenues, Madras, Prof. W. B. Hayes, Agricultural Institute, Allahabad, Prof. P. Maheshwari, Delhi University, Mr. B. M. Vencoba Rao, Development Secretary, Bhopal, Mr. C. L. Choi, Director, Land Reclamation, Bhopal.

General Administration :

Dr. B. P. Pal held charge as Director throughout the year.

The Central College of Agriculture was integrated with the Indian Agricultural Research Institute from 1st July 1951. The post of Principal of the College was abolished from that date and Dr. T. J. Mirchandani, Head of the Division of Agronomy, holds charge of this post in addition to his own duties, for which he is given a special pay of Rs. 150 p.m.

Shri J. M. Banerjee held the post of Registrar throughout the year.

The post of Personal Assistant remained vacant from 15th January, 1951 to 30th August, 1951. Shri K. C. Gupta assumed the charge of the post with effect from 1st September, 1951.

The Divisions of Agronomy, Agricultural Engineering, Chemistry, Entomology, Mycology and Botany remained throughout the year under the charges of Dr. T. J. Mirchandani, Shri R. V. Ramiah, Dr. S. P. Raychaudhuri, Dr. E. S. Narayanan, Dr. R. S. Vasudeva and Dr. N. Parthasarathy respectively.

The research schemes financed by the Indian Council of Agricultural Research, the Indian Central Sugarcane Committee and the Indian Central Oilseeds Committee which functioned at this Institute during the year under report are given below :—

(a) Schemes financed by the Indian Council of Agricultural Research :

1. Scheme for research on the cultivation of Kudzu Vine.
2. Scheme for the improvement of the maize crop in India.
3. Scheme for the establishment of a nucleus organisation for the introduction of new economic plants.
4. Co-ordinated wheat rust control scheme.
5. Scheme for research on nitrogen fixation in soils.
6. Scheme for research of minor or trace elements.
7. Scheme for tests with DDT, 666 and allied insecticides.
8. Scheme for Schools of Research in Entomology.
9. Scheme for Schools of Research in Mycology.
10. Key Village Scheme.
11. Phosphate Monograph Scheme.
12. Scheme for the preparation of a monograph on agriculture in ancient India (from 1st August, 1951).

(b) Scheme financed by the Indian Central Sugarcane Committee :

1. Scheme for the research on the diseases of sugarcane.

(c) Scheme financed by the Indian Central Oilseeds Committee :

1. Linseed Rust Scheme.

Accounts .

The total expenditure of the Institute and its Sub-stations at Karnal and Pusa during the financial year ending 31st March, 1952 amounted to Rs. 19,92,266/- as under :—

General expenditure of the Institute including the office of the Director, Irrigation, Power Supply, Gas Plant and Estate Establishment ...			Rs.
	...	...	4,74,814
Division of Statistics	...	...	22,115
Division of Chemistry	...	...	2,70,574
Division of Mycology	...	...	1,26,244
Division of Entomology	...	...	1,75,085
Division of Botany ...	...	...	1,79,137
Division of Agronomy	...	...	3,26,586
Division of Agricultural Engineering	...	...	1,36,709
Division of Agricultural Economics	...	...	6,804
Central College of Agriculture (for the last 8 months of the last financial year) ...	...	...	1,27,170

Rs. 18,45,238

Experimental Farms

Agricultural Sub-Station, Karnal	...	...	95,101
Botanical Sub-Station, Pusa	...	...	51,927

Rs. 1,47,028

Rs. 19,92,266

PART II

REPORTS OF THE HEADS OF DIVISIONS FOR 1951-52

REPORT OF THE DIVISION OF AGRONOMY (INCLUDING AGRICULTURAL RESEARCH SUB-STATION, KARNAL) FOR THE YEAR 1951-52

(Dr. T. J. Mirchandani)

During the year under report the activities of the Division at Delhi were under the following heads :—

Weather and its effect on crops ; manurial experiments with nitrogenous, phosphatic, Potassic fertilizers and manures, their combinations and micronutrient elements ; cultural and cultural-cum-manurial experiments ; rotational, mixed cropping and cultivator's holdings ; varietal and varietal-cum-manurial trials ; agrostology, irrigation experiments ; maximised production ; farm economics ; cattle breeding and management.

Weather and its effect on crops :

The Division of Soil Science and Agricultural Chemistry continued to be in charge of the Observatory but for obvious reasons the record of meteorological observations is summarised below :—

		Mean Max. temp. °F	Depart- ure from Normal	Mean Min. temp. °F	Depart- ure from Normal	Mean relative humidity % at 7 A.M.	Total rainfall (inches)	Depart- ure from Normal	Mean Wind velocity miles/ hr.	Mean hrs. bright Sun- shine	Mean evapora- tion in inches per day.
July	1951	100.7	+5.1	81.8	+1.2	67.6	3.44	-3.99	5.96	8.00	0.5273
August	"	93.2	+2.1	79.2	+0.2	81.6	2.51	-2.47	4.05	6.64	0.2821
September	"	93.8	+1.1	74.7	+0.4	74.4	2.45	-3.06	3.55	7.51	0.2932
October	"	97.3	+5.6	70.1	+6.4	64.4	0.04	-0.35	2.24	9.42	0.3112
November	"	83.8	-0.1	54.8	+4.2	66.6	0.53	+0.53	2.06	8.46	0.1960
December	"	73.3	0.0	42.8	-0.7	85.9	0.00	-0.16	1.19	9.26	0.1040
January	1952	71.9	+2.7	43.8	-0.4	84.3	0.33	-0.62	2.26	8.49	0.1092
February	"	77.0	+2.3	49.8	+2.6	83.6	0.40	-0.45	2.12	7.99	0.1400
March	"	83.9	-1.3	56.4	+0.4	63.4	2.83	+2.34	3.32	7.64	0.2661
April	"	100.2	+2.7	70.1	+1.8	41.1	0.73	+0.47	3.34	9.00	0.4903
May	"	104.3	-0.5	77.2	-0.5	38.3	1.29	+0.89	3.78	8.69	0.5608
June	"	101.8	-1.8	80.5	-0.8	57.2	1.51	-0.06	6.76	6.39	0.5937

Throughout the period under report the weather, in a general way, was unfavourable for crops. Due to almost complete failure of monsoon, *kharif* crops had to be sown with irrigation and as the irrigation facilities were not enough to cope with the full sowing programme, sowings were delayed. This in turn delayed sowing of *rabi* crops. High temperatures and low humidity in September-October also hindered sowing of early *rabi* crops like berseem in time. All the crops after sowing had to be irrigated more frequently and this led to great difficulty in supplying adequate irrigation for proper development of crops. Due to higher than normal temperatures in the winter months vegetative growth was more pronounced and there was lodging with high winds in February-March. Wheat

NP 771 and NP 165 flowered earlier than usual. The hailstorm on the 1st March, 1952, caused extensive and severe damage to the standing crops. Two subsequent hailstorms added to the damage already done.

Yield of crops : The average yield per acre of major crops in the farm during the year is given below :—

Crop								Total area	Yield in mds. per acre
Wheat	..	..	..	..	..	..	..	78.33	9.74
Oats	..	..	..	..	..	..	..	53.05	17.59
Barley	..	..	..	..	..	..	..	10.23	10.93
Peas	..	..	..	..	..	..	..	23.26	6.44
Gram	..	..	..	..	..	..	..	2.62	4.34
Berseem	..	..	..	..	..	..	..	47.66	342.265
Maize	..	..	..	..	..	..	..	51.17	9.92
Sugarcane	..	..	..	..	..	..	..	13.01	528.53

Low yields reported above are due to the severe hailstorm which hit the farm on the afternoon of 1st March, 1952. As practically all the crops were nearing maturity the damage caused was very extensive. Estimate of damage caused to major crops on the farm was of the following order :

Wheat 40-90 per cent., Oats 50-60 per cent., Peas 60-70 per cent., Gram 70-80 per cent. and Sugarcane 5-10 per cent. In Berseem the third cutting was completely spoiled.

Manurial experiments :

Relative value of rabi legumes : Different legumes were grown with and without phosphates in rabi 1950-51 and buried as green manure. The effect on the subsequent crop of maize grown in kharif 1951 was as follows :

Yield of maize grain in mds. per acre.

								Without P ₂ O ₅	With 80 lbs. P ₂ O ₅ /acre	Average
A. Berseem	..	..	..	..	..	..	..	21.00	18.70	19.87
B. Senji	..	..	..	..	..	..	..	18.00	16.70	17.38
C. Methra	..	..	..	..	..	..	..	12.80	11.40	11.85
D. Khesari	..	..	..	..	..	..	..	15.68	15.54	15.61
E. Gram	..	..	..	..	..	..	..	14.94	14.00	14.46
F. Peas	..	..	..	..	..	..	..	15.17	14.57	14.88
G. Lentil	..	..	..	..	..	..	..	13.40	11.70	12.58
H. Fallow	..	..	..	..	..	..	..	10.40	12.90	11.6
Average								15.10	14.46	..
F test	..	..	..	..	..	..	..	Not Sig.	Not Sig.	..
S. Em.	..	..	..	..	..	..	..	±0.99	±0.99	..

Main plot treatments and interactions were not significant. This is in conformity with the previous year's results. The sub-plot treatments also were not statistically significant. This did not confirm last year's results when application of P_2O_5 to legumes gave higher yields of maize than where no P_2O_5 was applied.

In *rabi* 1951-52 the legumes were grown again, their yields recorded and they were buried as green manure.

Green manuring experiment on wheat (time of burying sunnhemp) with and without fertilizers : Summary of the data for the current year was as follows :

Time of burying Sunnhemp	Fertilizer	Super @80 lbs. P_2O_5 p. acre	$(NH_4)_2 SO_4$ @ 15 lbs. N/acre	Super $(NH_4)_2 SO_4$ at the above rate	Control	Average
A. Sunnhemp buried after 4 weeks		15.81	12.92	16.26	12.03	14.25
B. Sunnhemp buried after 6 weeks		12.03	10.02	13.81	9.58	11.36
C. Sunnhemp buried after 8 weeks		20.05	14.26	22.94	12.92	17.54
D. Sunnhemp buried after 10 weeks		16.04	13.81	17.60	11.36	14.70
Average		15.98	12.75	17.65	11.47	..

Both main plot and subplot treatments were significant at 1 per cent. C.D. for Main plot treatments was 2.75 mds./acre and that for subplot treatments 2.82 mds./acre. In conformity with the previous year's results sunnhemp buried after 8 weeks gave the highest yield. Superphosphate at 80 lbs. P_2O_5 /acre at sowing sunnhemp plus 15 lbs. N/acre as ammonium sulphate at burying had the best effect. It appeared, therefore, from last two years' results that for green manure purposes sunnhemp should be grown with superphosphate and buried when 8 weeks old with a little nitrogen.

Response curve of nitrogen with wheat : The object of this experiment was to find out the standard response curve of nitrogen. The plots received a basal dressing of 40 lbs. P_2O_5 and 60 lbs. K_2O per acre. Increasing doses of nitrogen at intervals of 10 lbs. per acre were applied and the response observed. No manure plot gave an yield of 11.8 mds. per acre while the highest yield with N-50 P-40 K-60 was 19.67 mds. per acre. The treatment differences were significant at 5 per cent. but the responses with increasing doses of nitrogen were not regular as was to be expected. Similar results were obtained in the previous year also.

In another experiment on the effect of *different forms of inorganic nitrogen on wheat*, ammonium sulphate, ammonium nitrate, sodium nitrate and urea were compared. The plots received a basal dose of 40 lbs. P_2O_5 and 60 lbs. K_2O . There was no difference between these fertilizers among themselves but they were all superior to no manure.

Comparison of the response of sulphate of ammonia, cake and F.Y.M. at different levels of nitrogen on wheat : In *kharif* 1951, the residual effect of manures and fertilizers applied to the previous wheat crop was studied by growing maize for fodder. No residual effect was noticed in any of the treatments. In *rabi* 1951-52 wheat C 518 was grown again with the same treatments. The treatment differences were significant at 5 per cent. Groundnut cake at 80 lbs. N/acre again this year gave the highest yield.

Manurial experiment with nitrogen and phosphorus on potato : This experiment has been in progress for the last three years. The results obtained with Phulwa crop were as under :

Treatment	Yield of tubers in mds. per acre	F test
N ₀ -40 lbs. N/acre as (NH ₄) ₂ SO ₄	193.07	..
N ₁ -80 lbs. N/acre as (NH ₄) ₂ SO ₄	223.40	Significant.
N ₂ -120 lbs. N/acre as (NH ₄) ₂ SO ₄	251.52	C. D. at 1% 10.70
P ₀ -30 lbs. P ₂ O ₅ /ac. as Superphosphate	227.02	..
P ₁ -60 lbs. P ₂ O ₅ /ac. as Superphosphate	221.43	Not Significant
P ₂ -90 lbs. P ₂ O ₅ /ac. as Superphosphate	226.83	S. Em. ± 2.68
D ₀ -fertilizers applied broadcast	221.00	..
D ₁ -fertilizers applied 1" below tuber	225.05	Not Significant
D ₂ -fertilizers applied 2½" to the sides and 1" below tuber	223.23	S. Em. ± 2.68

The differences in yield between the three levels of nitrogen are significant. Other treatment differences are not significant. Results in the previous two years were also the same. For placement only in the first year D₂ was superior to D₁ or D₀, in other years the treatment differences were not significant.

Plant composition as an index of fertilizer requirement : Summary of results on maize grain yield (mds./acre) due to different treatments was as follows :

N80 33.7	N40 28.8	N ₀ 18.2	S. Em. ± 1.06	C. D. at 1% 4.53	N ₂ > N ₁ > N ₀
P40 29.5	P80 27.5	P ₀ 23.7	S. Em. $+1.06$	C.D. at 5% 3.25	P ₁ P ₂ P ₀

The analysis indicates that all three levels of nitrogen differ significantly from each other. The levels of P80 & P 40 do not differ significantly between themselves but both are superior to P₀. A wheat crop NP 710 was taken in the same plots without any fertilizers. Results on wheat grain yield (mds./acre) were as follows :

N 80 9.07	N 40 7.23	N ₀ 4.78	S. Em. ± 0.26	C. D. at 1% 1.10	N80 > N40 > N ₀
P80 7.82	P40 6.91	P ₀ 6.55	S. Em. ± 0.26	C.D. at 5% 0.79	P ₈₀ P ₄₀ P ₀

Here in the residual effect also, all three levels of nitrogen differ significantly from one another and P 80 is superior to P₀. In the previous two years in both maize and wheat only nitrogen effects were significant. This is the first year when phosphate has shown response.

A field experiment to determine the nutritional requirement of the farm soil was started in rabi 1950-51 with the object of finding out if any micronutrient deficiency existed in the farm soil. The crops were Rape (Toria), oats, tobacco in rabi and maize and jowar in kharif. Rape crop was damaged by locusts. The treatments were NoPoKo, N40 P60 K30, N40 P60 K30+Fe, N40 P60 K30+Mn, N40 P60 K30+Zn, N40 P60 K30+B, N40

P60 K30+all micronutrients. The yields due to N40 P60 K30, alone and in conjunction with different micronutrients were significant over 'no manure' in all the above five crops. Micronutrient sprays differed significantly only in the case of *jowar* crop when iron and magnesium treatments were significant over all other treatments. In other crops also iron spray gave the higher yields though the differences in yield over other treatments were not significant.

Effect of low doses of phosphates on berseem and after effects on wheat : This experiment which is in its second cycle consists of phosphate manuring of berseem for three consecutive years with unmanured Cowpeas grown for fodder in *kharif* followed by three unmanured crops of wheat in rotation with (i) Cowpeas for green fodder and (ii) fallow to study the after effects of phosphate manuring of berseem. During the year cowpeas and wheat (C 518) were taken. The yields were as follows :—

	Yield in Mds./Acre		
	Cowpeas (Green fodder)	Wheat after cowpeas	Wheat after fal- low
A. F. Y. M. 16 lbs. P_2O_5 acre	36.2	12.79	14.92
B. „ 32 „	48.9	16.10	15.80
C. „ 64 „	38.7	18.23	18.82
D. Superphosphate 16 „	33.2	14.19	13.82
E. „ 32 „	80.9	16.91	16.91
F. „ 64 „	41.6	30.44	21.32
G. Superphosphate 8 lbs. P_2O_5 /acre + F. Y. M. 8 lbs. P_2O_5 /acre	44.1	15.86	16.17
H. „ „ + „ 24 „	31.9	14.92	17.57
I. „ „ + „ 56 „	49.7	18.23	18.67
J. „ 24 „ + „ 8 „	43.1	16.98	18.38
K. „ 56 „ + „ 8 „	48.0	20.14	21.83
L. No manure	33.9	12.72	11.47
M. Fallow in <i>rabi</i> (no berseem)	56.8	9.04	11.54
F test	Not Sig.	Sig.	Sig.
C. D. at 5%	..	0.3	3.33

In yields of cowpeas the treatment differences were not significant though in the previous year they were. In yield of wheat the treatment differences were significant. Highest dose of phosphate either in the form of super of F.Y.M. or their combination gave the highest yield. This is in conformity with the results obtained in the previous years.

Building up of soil fertility by growing phosphate manured berseem with 'guar' in rotation : In this experiment superphosphate alone or in combination with potash was applied to berseem before sowing for three years. Unmanured *guar* was grown in *Kharif*

in rotation with berseem. *Guar* crop failed in all three years due to water-logging. The study of the extent of fertility built up was followed by growing : wheat-maize (fodder), wheat-fallow-wheat. In yield of wheat after fallow taken during the year, the treatment differences were not significant. This was the general conclusion also from the earlier wheat crops showing that in this case fertility was not built up by phosphate manuring of berseem.

Effect of phosphate manuring of berseem with and without potash and residual effect on maize-wheat-sorghum : The experiment is in its third cycle. The treatments were Main plot : Two levels of phosphates as Ammophos, Superphosphate and Superphosphate+ $(\text{NH}_4)_2\text{SO}_4$ to supply as much nitrogen as in ammophos used and subplot three levels of potash. During the year wheat and maize crops were taken. In yield of maize the main plot treatment differences were not significant. But in the yield of wheat the differences were significant. This was also the conclusion in the past two cycles. No effect of potash was noticed in any crop in any circle. The water-logged condition of the field in *kharif* leading to unsatisfactory growth of the maize crop might be the reason for maize showing no response.

Phosphate manuring of berseem with and without potash and/or nitrogen in berseem-maize-berseem-cotton-wheat-rotation : The second cycle of the experiment started in *rabi* 1951-52. The yields of berseem fodder were as follows :

										Yield of Berseem green fodder in Mds./acre.
A. No Po Ko	..	..	..	..	..	..	..	..	..	284.31
B. No P120 Ko	..	..	..	..	..	..	..	..	..	709.73
C. No P120 K120	..	..	..	..	..	..	..	..	..	712.85
D. N100P120K ₀	..	..	..	..	..	..	..	..	..	851.04
E. N 25 P120 Ko	..	..	..	..	..	..	..	..	..	754.18
F. N50 P120 Ko	..	..	..	..	..	..	..	..	..	784.27
G. N100 P120Ko	..	..	..	..	..	..	..	..	..	872.95
H. Fallow										
F test	..	..	..	..	..	..	..	..	..	Significant.
C. D. at 1%	..	..	..	..	..	..	..	..	..	43.79
										GD FE CB A

Response of berseem to fertilizers and comparison of after effects with Direct Manuring of Cereals : This is the second cycle of the experiment where the after effects of berseem manured with different fertilizers were compared with direct manuring of maize in *kharif* and wheat in *rabi*. With maize the results were not significant. There was a difference of 7.4 mds. of fodder in favour of direct manuring over the indirect one but this was not significant. In the case of wheat again the difference between the direct and indirect manuring was not significant. These results confirm the previous finding observed in the first cycle. Treatment of berseem with a complete fertilizer, N40 P120 K80 not only has increased the yield of berseem but improved the fertility status of the soil to the extent that an additional dose of 40 lbs. N/acre in the form of ammonium sulphate both in the case of maize and wheat was rendered unnecessary.

Effect of boron and molybdenum singly and in combination on berseem grown with and without phosphates : The maize crop raised in M.B.12A. the old site of the experiment with a basal dressing of 20 lbs. N/acre as $(\text{NH}_4)_2\text{SO}_4$ to study the residual effect, if any, of two years fertilized berseem gave the following results : In yield of maize grain the major elements were not significant even at 5 per cent. level but micronutrients were significant at 1 per cent. The mean yields were 23.9, 27.4, 23.1 and 18.9 mds./acre for boron(B), molybdenum(Mo), boron+molybdenum (B+Mo) and control (C) or no micro-nutrient.—C.D. @ 1 per cent. =2.0 mds./acre.

Residual effect of phosphate in NPKCa experiment : The mean yields of wheat after none, 80 and 160 lbs. P_2O_5 /acre to berseem were 9.4, 10.6 and 13.6 mds. respectively. The differences were significant at 1 per cent. showing the phosphate manuring of berseem had built up soil fertility.

Cultural and cultural-cum-manurial experiments :

Cultural-cum-manurial-cum-varietal trial on Sugarcane : In this experiment variety Co 453 gave significantly higher yield of cane and sugar in juice over Co 312. The nitrogen doses of 80 and 160 lbs./acre significantly increased the yield over no manure treatment but the higher dose of nitrogen was not significant over the lower dose (No-461.9, N 80-532.5, N 160 536.3 mds./acre, C.D. at 1 per cent. = 38.7). The effect of phosphatic fertilizers was not evident. All interactions with cultivation treatments were significant. In general deeper cultivation together with nitrogen doses of 80 and 160 lbs./acre and/or improved variety, Co 453 enhanced the yield.

Cultivation-cum-manurial experiment in a rotation of maize-berseem-fallow-wheat (clay loam soil) : This is the second year of the experiment being tried on a heavy soil. The yields of wheat (C 518) in Mds./acre were 25.63, 26.52, 26.31 and 22.53 for tractor ploughing followed by country plough (C2), country plough (C3) and tractor disc (C4) respectively, and 23.47, 24.69, 26.35 and 26.47 mds./acre for no manure (No), F.Y.M. at 40, 80 and 120 lbs. N/acre respectively. Both cultivation and manurial treatments were significant at 5 per cent. C.D. for cultivation treatments was 2.66 mds. and for manurial treatments 3.04 mds. respectively. Conclusions C2 C3 C1 C4, N120 N80 N40 No.

Manurial-cum-cultural experiment on maize : This experiment was conducted with the object of studying the effects of varying doses of nitrogen (20, 40, and 60 lbs. N/acre) and Phosphate (40 and 80 lbs. P_2O_5 /acre) with and without basal dose of F.Y.M. $\times$ spacing between the rows (2, 2.5 and 3 ft.) $\times$ broadcast *vs.* placement of fertilizers ($2\frac{1}{2}$ " to the sides and 1" below the seed). Yield differences due to nitrogen treatments were significant, C.D. at 1 per cent. = 2.00 mds./acre. The mean grain yields with 20, 40 and 60 lbs. N/acre were 14.28, 16.52 and 17.08 mds./acre respectively. No other treatments or interactions showed significance.

In another *Manurial-cum-cultural experiment on maize*, the effects of ploughings (2, 4 and 6) $\times$ interculture hoeings (1, 2 and 3) and removal of weeds $\times$ broadcast *vs.* placement of fertilizers (plough sole and lap of furrow) were compared. There was no difference between the various frequencies of cultivation. The interculture treatments were highly significant in favour of 3 hoeings. The yields were 17.82, 17.72, 20.11, and 17.26 mds./acre for 1, 2, 3 hoeings and removal of weeds respectively. The highest yields were obtained when 2 ploughings were combined with 3 hoeings. In methods of applying fertilizers the best treatment was plough sole placement. It gave 33 per cent. more yield than the conventional broadcast application.

Placement of fertilizers with maize : Placement of fertilizers at $2\frac{1}{2}$ " below the surface was significantly superior to broadcast or placement at $4\frac{1}{2}$ " below the surface. The yields were 13.2, 15.3 and 13.8 mds./acre for broadcast, $2\frac{1}{2}$ " and $4\frac{1}{2}$ " placements respectively. There was no difference between 20 and 30 lbs. N/acre application but 60 lbs. was significantly superior to both of them. These results confirm previous year's findings. The residual effect of the fertilizers was studied on oats. The effects of nitrogen alone was significant and conclusions were the same as that in the direct effect.

Cultural experiment on cotton : The treatments were : Sowings (25th April, 10th May, 25th May and 10th June) $\times$ varieties (M 4, F 216, F 320 and L.S.S.) $\times$ spacing (2', $2\frac{1}{2}$ ' and 3'). May and April sowings were significantly superior to June sowings. Mean yields of seed cotton in Mds./acre were 16.76, 16.07, 15.72 and 12.43 for 25th April, 10 May 25th May and 10th June sowings respectively. This is in conformity with the previous year's result. F320 gave the highest yield followed by M₄ as against last year when F216 gave the highest yield followed by F320. Differences in yield between the different spacings were not significant.

Tillage experiment on wheat : Four frequencies of ploughing with and without fertilizer and with and without weeding (one or two) were studied in this project. The yield of wheat (NP775) was 4.58, 7.04, 8.82 and 8.85 mds./acre for 3, 6, 9 and 12 ploughings respectively. Nine and twelve ploughings were significantly superior to 6 or 3 ploughings. 40 lbs. N/acre as ammonium sulphate was significantly superior to 'no manure'. One weeding gave significantly better yield than 'no weeding' or two weedings. 'Two weedings' again was superior to 'no weeding'.

Seed rate-cum-varietal-cum-manurial experiment on wheat : The treatments were varieties (NP 165, C 518) $\times$ Seed rates (50, 65, 80, 95 and 110 lbs./acre) $\times$ nitrogen doses (0, 20 lbs. N/acre). The effect of seed rate was not significant. N.P.165 was better than C 518 (N.P.165 and C 518 gave 15.45 and 11.04 mds./acre respectively, C.D. at 5 per cent. was 0.709 mds./acre). In nitrogen treatments differences were not significant. No other interaction except variety $\times$ nitrogen was significant, when variety NP 165 with 20 lbs. N/acre gave the highest yield.

Rotational, mixed cropping and small holdings :

Three six acre small holdings under irrigated conditions were started in 1947-48 with a view to investigate (i) the effect of phosphate manuring on the yield of legumes and residual effect on subsequent crops in rotation, (ii) the economics of such small holdings under different rotations, (iii) if the size of the holdings is adequate in maintaining a small family and cattle required to run the holdings. The first cycle of the sequence of cropping will be completed in 1952-53 when results will be reported and final conclusions drawn.

Mixed cropping—Kharif crops : This is the third year of the experiment. During the year the results were as follows :

	Kharif 1951			Rabi 1951-52
	Maize (grain) Mds./acre	Cowpeas (grain) Mds./acre	Jowar + cowpeas fodder Mds./ acre	Oats (grain) NP ₁ Mds./acre
A. Maize alone	3.25	..	..	10.17
B. Jowar alone	..	..	123.75	10.92
C. Cowpeas for grain	..	1.66	..	10.29
D. Cowpeas for fodder	..	..	130.25	8.21
E. Maize + cowpeas for grain (1 : 1)	4.37	1.13	..	12.12
F. Maize + cowpeas for grain (1 : 2/3)	3.87	0.56	..	10.13
G. Maize + cowpeas for grain (1 : 1/3)	2.75	0.30	..	8.09
H. Jowar and cowpeas for fodder (1 : 1)	..	..	213.37	10.05
I. Jowar and cowpeas for fodder (1 : 2/3)	..	..	177.37	8.21
J. Jowar and cowpeas for fodder (1 : 1/3)	..	..	135.37	10.66
F test	Sig.	Sig.	Sig.	Not Sig.
C. D. at 5%	1.00	0.64	36.52	..
Conclusions	<u>EFAG</u>	<u>Cowpeas</u> <u>CEFG</u>	<u>HIJDB</u>	

Mixed cropping of maize and cowpeas for seed and Jowar and cowpeas for fodder in the ratio of 1 : 1 showed the best performance.

Mixed cropping—Rabi crops (II) : In this experiment wheat and gram were each sown alone or both together in mixtures of different proportions (1 : 1/4, 3/4 : 1/2, 3/4 : 1/4) sown wheat first crosswise or gram first crosswise or both in the same row. In yield of wheat grain the differences were not significant. Gram sown alone gave the highest yield. Yield differences due to different modes of sowing were not significant.

Varietal-cum-manurial trials :

Response of different varieties of wheat to nitrogen : The treatments were varieties (NP 165, NP 710 and NP 771) × sowing dates (20th October, 15th November and 10th December) × manures (no manure, 20 lbs. N/acre at sowing or at first irrigation, 40 lbs. N/acre at sowing or at first irrigation). Yield differences due to varieties were only significant, other differences and interactions were insignificant. NP 165, NP 710 and NP 771 yielded 6.90, 6.39 and 5.04 mds./acre respectively. These results do not confirm the findings in the earlier year.

In another experiment on *varietal-cum-manurial trials on NP and Punjab wheats* the treatments were varieties (NP4, 12, 80-5, 165, 710, 715, 718, 721, 760 and 775, C13, Pb. C217, C 518 and C 591) × manure (no manure and N20 P30 K20). NP 165 showed the best performance. C518 did also equally well. N20 P30 K20 was significantly superior to no manure.

Varietal-cum-manurial trial on sugarcane : Out of varieties Co 312, Co 647, Co 659, Co 712, Co 728 and Co 739, variety Co 647 outyielded others in cane tonnage. In respect of per cent. sucrose in juice Co 659 was best. The nitrogen doses 40, 80 and 120 lbs./acre did not improve cane yield.

Varietal-cum-manurial trial on linseed : The treatments were varieties (NP21, B 5128, Dakota flax and Sheyanne flax) × nitrogen doses (0, 20 and 40 lbs. N/acre). Variety B 5128 was significantly superior to others. In the preceding two years NP 21 had given best performance. The fertilizer treatments did not show any response.

Varietal-cum-manurial trial on tobacco : In leaf yield varieties showed significant difference at 1 per cent. level. Hybrid S 19 and S22 were significantly higher yielding than hybrids S14 and S20. In the preceding year S19 gave the highest yield of leaf tobacco. There was no difference between no manure and 40 or 80 lbs. N/acre.

Varietal trial : Linseed : The varieties included were NP 21, RR 10, RR 191, RR 193, RR197, RR 208 and RR 236. The rust resistant strain RR 208 gave significantly higher yield than other varieties. In the previous year the yield differences among the varieties were not significant.

Sweet potato : Type FA 17 outyielded by about 50 mds./acre other varieties, e.g., B219, T.S.T. white and FB 4004 included in the trial.

Sannhemp : In yield of wheat grown after green manuring with different varieties of Sannhemp, varieties Kanpur 12 and UP 5-1 were equal and they both were superior to Assam 5-1, D13, UP5-2, D-20, D11, B.O. 32-1.

Maize : Varieties Pusa yellow No. 2 and Guntur were significantly superior to 'Nodak'. The yields were 3.84, 11.29 and 13.51 mds./acre for Nodak, Guntur and Pusa yellow respectively.

Agrostology ; collection of grasses and legumes, Ley farming : Kudzu vine :

During the year under report, tour was arranged in Assam to study the grasses and legumes and the tracts and make new collection. 46 additions were made to the legume and grass nursery bringing total to 168. Important additions to the legumes were *Centrosema pubescense*, *Indigofera endicaphylla*, *Lupinus termis* and *Rhynchosia himalenis*.

Among the new additions to the grasses *Urochlos* species showed promise. In a preliminary trial on Hubam clover-wheat mixture it was possible to get, after harvest of the wheat crop which yielded 18 mds. of grain/acre, the first cutting of Hubam clover 30 days after the harvest of wheat yielding 65 mds. of green fodder per acre. A second cutting yielding 58 mds. per acre, in June for green manure purposes could also be obtained.

Soyabean varietal trial : Five selected varieties from U.S.A. were tried for their grain and fodder yields. The varieties, during the year under report, did not show any significant differences either in grain or fodder yield. Statistical analysis of the three year data showed 'Charlee' to be inferior to the other four amongst whom there was no difference.

Ley farming—New series : The experiment was started in 1949-50. In June 1950 one year ley plots were ploughed under and in June 1951 the two year ley plots. Unmanured maize and wheat crops were subsequently taken on these plots. Cereal rotation of maize and wheat was introduced as control.

Grain yield in mds./acre

	A <i>Dichanthium</i> mixture maize-wheat		B <i>Cenchrus</i> mixture maize-wheat		C <i>Rhodes</i> mixture maize wheat		D Cereal rotation maize-wheat		Average Maize-wheat	
One year ley-manured	6.80	9.17	8.02	10.45	6.80	9.84	7.78	8.38	7.35	9.46
One year ley-unmanured	4.81	10.36	8.51	9.20	7.05	9.62	4.86	8.25	6.32	9.36
Average ..	5.83	9.77	8.26	9.82	6.92	9.73	6.32	8.32	..	..

Maize : Ley treatments were not significant

Seed mixtures significant at 5%, C. D. = 1.51

B C D A *Cenchrus* mixture yielded significantly more than other treatments.

Wheat : Both ley treatments and seed mixtures were not significant.

1. Two year ley-twice manured	7.53	11.14	8.51	11.88	5.83	10.39	6.56	8.53	7.11	10.48
2. Two year ley-once manured	5.83	10.08	6.80	10.26	8.35	9.90	5.10	8.68	5.77	9.73
3. Two year ley-un- manured	4.62	9.62	5.83	11.03	4.33	9.93	5.35	8.50	4.98	9.77
Average	5.99	10.28	7.05	11.05	5.16	10.07	5.67	8.57	..	..

Maize : Ley treatments significant at 5%, C. D. = 1.337, $\overline{123}$

Seed mixtures significant at 5%, C. D. = 1.23, $\overline{BCDA}$

Wheat : Ley treatment not significant

Seed mixtures significant at 1%, C. D. = 1.36, $\overline{BCDA}$

Cenchrus mixture proved superior to other mixtures or cereal rotation.

Root study of grasses : During the year the root systems of two years stand of a few grasses were studied by weighing out the root material from 1 cubic ft. of soil. Quantity in gms. was 27.12, 63.48, 72.86, 75.42, 32.62 and 85.25 for *Dichanthium annulatum*, *Sehima newosa*, *Cenchrus ciliaris*, *Cenchrus setigerus*, *Chrysopogon montanus* and *Heteropogon contortus* respectively.

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Kudzu vine : Reports from private individual and Government farms in 17 different States to whom Kudzu crowns were supplied, indicate 67-70 per cent. sprouting. On the basis of 1/40 acre test plot Kudzu vine yielded 447 mds. of green fodder/acre in three cuttings taken during April, August and October. *I.C.A.R. Scheme* : Four crowns established during 1949 and transplanted in February 1950, flowered in September 1951. *i.e.*, after 17 months from transplanting. This was the earliest flowering recorded here. Agonomic treatments, *viz.*, defoliation, watering and staking failed to induce flowering in the vine in the second year also.

Spray irrigation : In an experiment on potato three spray treatments (100 per cent., 75 per cent. and 50 per cent. of the amount of water applied by surface irrigation) was compared with normal surface irrigation. There was practically no difference in yield between the four treatments, indicating that the practice of spray irrigation can result in 25 to 50 per cent. economy of water.

Maximised production :

In attempts to get the maximum yield of several crops under Delhi conditions the following were achieved :

Crop	Area	Yield in Mds/acre
Wheat ..	2.3 acres ..	17.6 (low yield was due to hailstorm damage).
Maize ..	0.5 „ ..	38.0
Potato (phulwa) ..	50' x 50' ..	507.0
Potato (Simla Special)	50' x 50' ..	537.7

Collaborative experiments : Collaborative experiments with D.D.T. for the control of white ants on sugarcane and wheat with the Division of Entomology and experiments on the 'value of compost' and effect of 'bhusa buried with and without artificials' with the Division of Chemistry remained in progress.

Seven experiments belonging to the Divisions of Chemistry, Botany and Mycology were in progress at the farm for which help was given as and when required.

In addition to the above collaborative work was in progress in different States in India as under :—

(a) *Experiments on use of ammonium magnesium phosphate.*

The above experiment was in progress at Kauki in Bihar and Burdwan in West Bengal. The results of two years have shown that there is no special advantage in the use of Ammonium magnesium phosphate over superphosphate, rock phosphate, ammophos and superphosphate plus ammonium sulphate.

(b) *Experiments on Chilean nitrate.*

100 tons of chilean nitrate were received from Messers Rallis India agents for conduct of experiments on all India basis. Due to transport difficulties, material could not be despatched to different States in time to conduct experiments in 1951-52. During the year experiments were started only at 6 places, but the results from all centres have not yet been received. The work has been started at many other centres during 1952-53.

(c) Grasses and legumes.

Collaborative trials on grasses and legumes :

1. General : 1. These trials were started in 1949-50 under which promising materials are sent for trial in the States. During the present year material was supplied to 10 stations.
2. Trial in the Rice tract of M.P. : 2. A trial on 3 grasses and 4 legumes was conducted in the paddy tract, Government Experimental Farm, Tharsa, Madhya Pradesh.

Broadcasting of seeds after the harvest of paddy gave the best establishment. All grasses are of good stand and amongst legumes *senji* gave the best yield followed by Hubam clover and *vicia*. The growth of *vicia* was observed to be excellent.

3. Trials on Kudzu Vine : Planting material was supplied to 43 centres in different States, including 15 trial centres under the I.C.A.R. Kudzu Scheme.

Cattle breeding and management :]

1. The strength of the herd at the close of the year was 51 head against 76 head at the beginning of the year. Twenty one cattle were transferred to the cattle-cum-dairy-farm at Karnal in January 1952. The animals maintained good health throughout the year.

2. Milk yield : The wet and overall averages as recorded during the year under report were 22.5 lb. and 13.5 lb. per cow per day respectively, as against 19.7 lb. and 11.9 lb. recorded last year. This represented substantial increase both in wet and over all averages. The highest wet average recorded was 26.4 in the month of February, 1952. The average yields of cows for the various lactations were 5,852 lb. in first, 4,974 lbs. in second, 6,748 lbs. in third, 7,311 lbs. in fourth, 6,618 lbs. in sixth and 3,253 lbs. in eighth lactation. Out of 15 cows which completed their lactations during the year under report two did over 8,000 lbs. per lactation. Out of two first calvers, one did over 5,000 lbs. and the other over 6,000 in a lactation period of 306 days.

3. Calf rearing : Eleven male and nine female calves were born during the year. Their average birth weights were 54.7 lbs. and 54.5 lbs. respectively. There were two deaths among the pail fed calves. The mortality among pail fed calves was five per cent. only. The growth rates of the pail fed calves were as follows :

Male calves (upto 6 months) : 1.34 lbs. per day. Female calves (upto 8 months) : 1.08 lbs. per day.

4. Early maturity experiment : Two early maturity heifers completed their lactations during the year under report. The performances of the early maturity first, second and third calvers are given below :

Description	No.	Age at 1st Calving			Avr. Milk Yield per Lactation—lbs		
		Years	Months	Days	I	II	III
First calvers	2	2	8	1	5852	..	..
Second calvers	4	2	4	20	5798	4874	..
Third calvers	5	2	8	1	6491	6807	6748

5. Four times milking and pre-milking : Four times milking and milking cows before calving continued as a routine practice. The weak or sick cows were milked twice or thrice according to their condition.

6. Sale of cattle : Four cows and seven young bulls were sold during the year under report. The total sale proceeds were Rs. 3,767.

Farm economics :

Farm costing studies remained in progress. The cost of production of crops for 1949-50 were worked out and these costs are summarised as under :—

CROPS

Particulars	Wheat grain	Barley grain	Oats grain	Peas grain	Gram grain	Berseem fodder	Jowar fodder	Maize grain	Maize & Cow-peas fodder
Area sown—acres	99	11	43	12	11	64	88	52½	27
Yield per acre—Mds.	19·7	15·7	18·3	7·5	12·0	429·3	149·0	12·4	240·0
Cost of production per md.—Rs.	9 2	10 12	10 0	25 0	17 0	1 7	0 13½	19 8	1 3

The costs of production of peas and maize were high owing to low yields per acre. The other costs are comparable to previous years.

The milk production costs were worked out for the years 1949-50, 1950-51, and 1951-52. The data are summarised as under :—

Particulars	1949-50	1950-51	1951-52
Total cost incurred Rs.	2,12,693	1,98,651	76,725
Total milk yield lbs.	6,17,763	5,61,125	1,55,541
Mean cost per lb. Rs.	0 5 6	0 5 8	0 7 10½

The costs of production for the two years 1949-50 and 1950-51 are comparable. The cost for 1951-52 is high as the herd strength had been reduced while overhead charges were maintained for the experimental and teaching dairy, at a high level.

Comparable costs for irrigation calculated from 1946-47 to 1950-51 are given as under :

	1946-47	1947-48	1948-49	1949-50	1950-51
Cost per acre per irrigation Rs.	35 2 6	47 15 0	39 10 0	37 6 0	25 11 6

These costs are very high. Even the lowest cost for 1950-51 of Jamna supplies is much above the level of tube well cost. Therefore a trial boring was carried out. Drilling upto 256 feet gave a discharge of 25,000 gallons per hour.

An economic study of mixed farming experiments run for eight years is in progress. The cost of maintaining a working pair of bullocks were compiled for the year 1949-50. The cost works out at Rs. 4/5/- as against Rs. 5/8/- for 1948-49. Costs of rearing calves were also compiled.

Intensive cultivation scheme :

During 1950, work on the intensive cultivation scheme was started in 19 selected villages round about Indian Agricultural Research Institute. The work was continued with the following results.

Variety NP 775 of wheat was extensively taken up for cultivation in the villages of Nilhanti, Hastal, Keshapur and Razapur. About 125 acres have been covered. In 21 plots of NP 718 the average yield of wheat was 19.61 mds. per acre. Barley NP 13

averaged 17.5 mds. per acre while oats (green fodder) about 297 mds. per acre. Peas NP 29 has established itself. About 10 tons of Sulphate of Ammonia was distributed for crops such as sugar cane, chillies and wheat.

Permanent manurial and rotation experiments at Pusa :

The experiment was conducted as per programme. The yields were poor due to low rain-fall in monsoon and late winter rains. The average yields of different crops on the substation were also of the same standard as obtained in the experiments.

Plot No.	A Series			B Series		
Treatment per acre	Kharif Maize yellow No. 2-lb./ac.	Rabi Barley N.P. 21 lb./ac.	Wheat N.P. 52 lb./ac.	Kharif Maize yellow No. 2-lb./ac.	Rabi Arhar N.P. 80 lb./ac.	Barley N.P. 21 lb./ac.
GROUP I						
1. No manure (Check plot No. 1)	864	174	..	256	771	..
2. F.Y.M. 4,000 lb.	1504	533	..	768	984	..
3. F.Y.M. 8,000 lb.	2000	718	..	864	1056	..
4. F.Y.M. 4,000 lb. + Rape cake 20 lb.N.	1968	800	..	934	923	..
5. Rape cake 40 lb.N	1696	626	..	704	974	..
GROUP II						
6. Am. Sulp. 40 lb.N	688	174	..	192	656	..
7. Pot. Sulp. 50 lb. K ₂ O ..	816	298	..	112	769	..
8. Super. 80 lb. P ₂ O ₅	784	513	..	336	923	..
9. Super. 80 lb. P ₂ O ₅ + Pot. Sul. 50 lb. K ₂ O. ..	1184	400	..	200	718	..
10. Am. Sulp. 40 lb. N + Super 80 lb. P ₂ O ₅ + Pot. Sulp. 50 lb. K ₂ O.	1264	656	..	480	861	..
11. Am. Sulp. 40 lb. N + Super. 80 lb. P ₂ O ₅ .	416	790	..	144	790	..
13. No manure (Check plot No. 2) ..	416	113	..	96	585	..
14. Am. Sulp. 40 lb. N + Pot. Sulp. 50 lb. K ₂ O.	280	164	..	128	615	..
GROUP III						
12. G.M. in purely cereal rotation. I ..	..	..	195	..	..	305
15. G.M. and legume in the rotation ..	..	687	..	352	738	..
16. As in No. 15 with super 80 lb. P ₂ O ₅ to the G.M. crop at sowing.	..	1333	..	656	944	..
17. No legume and no G.M. ..	152	..	10	400	..	23
18. No manure (Check plot No. 3) ..	336	100	..	168	364	..

Maize (A Series) : The treatments in order of merit were (i) F.Y.M. at 8,000 lb., (ii) F.Y.M. plus rape cake, (iii) rape cake, (iv) F.Y.M. 4,000 lb. and (v) N.P.K.

Maize (B Series) : The treatments in order of merit were (i) F.Y.M. at 8,000 lb., (ii) F.Y.M. plus rape cake, (iii) F.Y.M. at 4,000 lb., (iv) rape cake, (v) G.M. plus super.

Barley (A Series) : The treatments in order of merit were (i) G.M. plus super., (ii) F.Y.M. plus rape cake, (iii) NP, (iv) F.Y.M. at 8,000 lb. and (v) G.M. and legume in rotation.

Arhar ('B' Series) : The treatments in order of merit were (i) F.Y.M. at 8,000 lb., (ii) F.Y.M. at 4,000 lb., (iii) rape cake, (iv) G.M. plus super and (v) F.Y.M. plus rape cake and also superphosphate alone.

From the above results it will be seen that organic manures or green manure in conjunction with P_2O_5 gave the best results. The yield of crops was lowest in plots where purely cereal rotation was followed. Green manure in purely cereal rotation also gave very poor results.

New Manurial Experiments : Owing to adverse climatic conditions, as stated under the previous experiments, the yields of crops were very poor. The results obtained during the year under report are given below :

Yield of maize and gram in maunds per acre

Treatment per acre									Maize yellow No. 2	Gram N.P.58
A. No manure	..	..	..	..	..	..	..	..	4.14	3.97
B. F.Y.M. 8,000 lb.	..	..	..	..	..	..	..	..	8.04	6.90
C. Rape cake 40 lb.N	..	..	..	..	..	..	..	..	9.09	4.29
D. Am. sulp. 40 lb.N	..	..	..	..	..	..	..	..	5.94	2.75
E. Pot. Sulp. 50 lb. K_2O	..	..	..	..	..	..	..	..	4.45	2.86
F. 'Super 80 lb. P_2O_5	..	..	..	..	..	..	..	..	3.93	3.35
G. Super 80 lb. P_2O_5 +Pot. sulp. 50 lb. K_2O	..	..	..	..	..	..	..	..	3.82	1.73
H. Am. sulp. 40 lb.N+80 lb. P_2O_5 +Pot. sulp. 50 lb. K_2O	..	..	..	..	..	..	..	..	6.44	2.75
I. Am. sulp. 40 lb.N+super 80 lb. P_2O_5	..	..	..	..	..	..	..	..	6.83	3.29
J. Am. sulp. 40 lb.N+Pot. sulp. 50 lb. K_2O	..	..	..	..	..	..	..	..	6.96	2.41
'F' test	..	..	..	..	..	..	..	..	Sig **	Sig**
C.D. (5%)	..	..	..	..	..	..	..	..	2.13	1.52

** at 1 per cent. level.

Conclusions :—

Maize : C, B, J, I, H, D, E, A, F, G,

Gram : B, C, A, F, I, E, D, H, J, G

The above results show that rape cake and farmyard manure have given significantly higher yields than most of the treatments.

PROGRAMME OF WORK FOR 1952-53

1 Soil fertility problems :

(a) Manurial experiments on cereals and crops in rotation :

(i) *Nitrogenous manures and fertilizers* : Experiments to test the relative values of nitrogen in the organic and inorganic manures and also responses of their combinations on wheat, maize and paddy. Experiments to determine optimum time for the application of F.Y.M. and nitrogenous fertilizers.

(ii) *Phosphatic fertilizers* : Experiment with the different forms of phosphatic fertilizers to study their responses on *kharif* and *rabi* legumes and after effects on cereals following the legume.

(iii) *Nitrogenous and phosphatic fertilizers* : To study the relative merits of different types of nitrogenous and phosphatic fertilizers at ten experimental stations all over India.

(iv) *Nitrogenous, phosphatic, fertilizers* : Experiments to study the effect of these each at different levels and in combination on the yield of wheat.

(v) *Green manures* : Experiments with different legumes as green manures with and without fertilizers on wheat. Experiments to study the effect of green manuring when the crop is grown *in situ* and brought from outside. Green manuring experiment with *guar* in conjunction with micronutrients.

(vi) *Manurial and cultural experiments on sugarcane, cotton, maize, wheat, tobacco, potato and barley.*

(vii) *Permanent manurial and new manurial experiments at Pusa.*

(viii) *Micro-nutrients studies.*

(b) *Placement of fertilizers in row crops* : To effect economy in the quantity of fertilizer used and their better utilization by field crops.

(c) *Mixed cropping of cereals and legumes* : To study the possibility of maintaining soil fertility by growing a mixture of cereals and legumes under different fertilizer treatments.

(d) *Mixed Farming* : To obtain maximum over-all yields which a cultivator is likely to get from holdings of 6 acres under irrigated conditions designed to meet the requirements of his family members and cattle and produce milk for cash sale.

(e) *Rotational experiments* : To maintain the soil fertility by different crop rotation in conjunction with manuring.

2. Irrigation experiments :

(i) To study the influence of depth of furrows and fertilizers on irrigation of potatoes.

(ii) To study the effect of spray irrigation.

3. Cultural experiments :

Planting distance of potatoes and sweet potatoes, different preparatory tillage treatments on sugarcane, spacing in maize and cotton, tillage experiments on wheat and maize, potato and carrots, dates of sowing and intercultural experiments on maize.

4. Varietal yield trials :

Experiments will be conducted with improved varieties of different crops such as sugarcane, wheat, cotton, maize-hybrids ; chillies, pigeon pea and sunnhemp.

5. *Agrostology* :

To produce high yielding and palatable fodder grasses and legumes for cattle, increase the productivity of natural grasslands ; to work out suitable seed mixtures of grasses and legumes for pasture, to evolve a suitable system of ley farming. Maintenance of nursery.

CATTLE BREEDING AND MANAGEMENT

1. Line breeding and selection for improvement of milk yield.
2. Feeding of stock on balanced rations for growth, early maturity and high milk production.
3. Calf rearing on standardised milk ration containing 3.5 per cent. butter fat.
4. Early maturity treatments to test bulls for their transmitting capacity of high milk yield quality at an early age.

AGRICULTURAL RESEARCH SUBSTATION, KARNAL

As given in the earlier report, the Agricultural Substation, Karnal, passed through a reorganisation on 1st April 1951. This left the Sub-station with only 180.12 acres of land. Shri B. D. Ganguly, Assistant Agronomist, held charge of the Substation throughout the year under report.

As this was the first year of the set-up of the Substation considerable difficulty was experienced to manage the work due to insufficient equipment, accommodation, etc. While on the non-residential side, the godown and office accommodation fell short of their requirement, the residential accommodation allotted for the Substation staff is also far from satisfactory. Apart from the fact that the major number of the staff has been housed in lower types of quarters, some staff members could not be provided with those even. Suggestions for construction of new buildings have since been submitted.

Research projects :

Manurial experiments : A few manurial experiments with paddy were in progress. The results obtained from one of them in which paddy-berseem rotation was followed, showed that the paddy crop did not respond to nitrogenous manuring. In the succeeding crop of berseem the treatments indicated highly significant differences. Berseem gave superior yield when phosphate was applied either to the previous crop of paddy or directly to berseem. In another experiment, manuring of paddy in the nursery with different forms of nitrogenous manures was found to be highly significant. The treatments (i) farm-yard-manure and (ii) half farm-yard-manure plus half ammonium sulphate, were superior to ammonium sulphate. In paddy-wheat manurial experiment, in the case of paddy the whole plot was manured and in the subsequent crop of wheat half of the plot was manured and the other half remained unmanured. Among the doses of nitrogen, 60 lbs. N gave the best yield of paddy and was significantly superior to 30 lbs. N and Control. Among the combinations of N and P, 60 lbs. N plus 120 lbs. P_2O_5 gave the highest yield of paddy and was significantly superior to 30 lbs. N plus 120 lbs. P_2O_5 , 120 lbs. P_2O_5 , 30 lbs. N plus 60 lbs. P_2O_5 , 30 lbs. N and Control. In the case of wheat, the difference between the treatments 'manured in rabi' and 'not manured in rabi' was highly significant.

In green manuring experiment sunnhemp gave significantly higher yield of wheat than moth and Control.

Varietal trials : In the wheat varietal trial, N.P. 718, C-591 and N.P.720 gave the best results. Among the seven varieties of linseed, R.R.236 yielded the best and next to it was R.R.197.

Cultural experiments : Experiments to test the merits of seed bed preparation with tractor plough and bullock drawn inversion and non-inversion ploughs for wheat were in progress. The results obtained did not show significant differences among the cultural operations. In another experiment with paddy, broadcasting of seed gave better yield than drilling of seed and transplanting of seedlings.

Seed Supply : Seeds of improved varieties of crops were distributed. The total quantity supplied was about 696 maunds.

REPORT OF THE DIVISION OF BOTANY FOR THE YEAR 1951-52

(INCLUDING BOTANICAL SUBSTATION, PUSA)

(Dr. N. Parthasarathy)

The research work of this Division is broadly divided into four sections. The section of Plant Breeding and Genetics is concerned with evolving new and improved varieties of crop plants by employing different techniques of breeding and trying the promising selections in the various states. The research work undertaken in the section of Cytology and Cyto-genetics, mainly relates to the study of the behaviour of chromosomes in interspecific and intergeneric hybrids and in chemically induced variations of crop plants. This branch of science has assumed great importance in recent years for the purpose of successful plant breeding. The section of Plant Physiology, has been studying the nutritional requirement of wheat, factors concerned with drought resistance and lodging in wheat, use of synthetic hormones in the suppression of weeds and their effect on growth of crops, and study of factors concerned with yield. The section of Systematic Botany and Plant Introduction is concerned with introduction of desirable plants from foreign countries, their trials in India, maintenance and classification of crop varieties, study of weeds of crop fields, exchange of seeds, etc. Besides free collaboration between these sections, the Division as a whole has recently undertaken some special work like descriptions of genetic stocks of Indian wheats in cooperation with such foreign bodies like the Food and Agricultural Organisation.

A summary of the work and the results obtained in the different sections, during the year under report is given below :—

PLANT BREEDING AND GENETICS

Breeding of wheat varieties for resistance to rusts :

Selection of varieties resistant to rust was continued. A large number of exotic varieties, including 572 strains obtained from the U.S.A., were studied for their rust reaction both under natural and under artificial conditions of infection. It was found that, under artificial conditions of infection, 136 varieties showed resistance to black rust, 323 varieties to brown rust and 400 varieties to yellow rust. Out of the collections received from the U.S.A., 82 varieties were found to be resistant to all the three rusts at Delhi. A large number of hybrid progenies in different generations, backcrosses and double crosses were further studied and about 500 selections were made, based on their rust reactions and agronomic characters. Seedling-resistance tests were carried out at Simla by the Mycology Division on 15 single crosses in different generations and three backcrosses in the first generation. Eleven selections, from crosses of *Gabo* with T.P. 710, Niphad 4, N.P. 165, and N.P. 761, which were in F_2 and F_3 generations, showed resistance to a mixture of races of black rust and six selections showed resistance to brown rust races.

Studies on the inheritance of rust resistance and other characters were continued. In two crosses (E. 323 $\times$ N.P.52 and E. 323 $\times$ N.P. 165) in their F_2 generations, high resistance to black rust appeared to be recessive, while the susceptibility to the same was dominant. Hybridisation work involving about 50 new crosses and about 20 back and double-crosses were also carried out according to programme.

Yield trials : (a) *Trials of exotic varieties :* This was conducted at Delhi with seven exotic varieties, viz., E. 821, E. 568, E. 559, E. 572, E. 560, E. 570 and E. 750 and three controls, viz., N.P. 165, N.P. 710 and C. 591. The control C. 591 gave the maximum yield of grain and was followed very closely by E. 821. This was followed by E. 568 and N.P. 710. Although the incidence of rust was not heavy, none of the varieties were completely free from rust.

(b) *Trial of rust resistant strains :* Trials were conducted at Simla with 13 strains of wheat resistant to black rust. One strain (No. 100) evolved from the wheat cross, W. 245, out-yielded all others. This was followed by N.P. 165 which was used as one of the controls.

Twenty-four improved varieties of wheat evolved at the departments of agriculture in five different states were grown at Delhi along with four controls, viz., N.P. 165, N.P. 710, N.P. 760, and C. 591 ; Pb.C. 281 out-yielded all others and the performance of this variety was followed by that of M.P. Hyb. 11-6 and Rajasthan 31-4. Altogether five strains gave better yields than N.P. 760 which was the best amongst the types used as controls. In another trial, the Australian variety "Festival" gave a poor grain yield when compared to N.P. 165, N.P. 760 and C. 591, but it was remarkably free from all the three rusts under natural conditions of infection. Under artificial conditions of infection however, "Festival" showed some susceptibility to individual races of the rusts at the seedling stage.

Loose smut tests : Some wheat varieties of the "N.P. 700—series", exotic varieties and some improved strains obtained from different states were studied regarding their reaction to loose smut (*Ustilago tritici*).

2. Improvement of the rust resistant linseed strains :

Replicated row trials of 100 newly-evolved, early maturing, rust-resistant strains were conducted under conditions of artificial infection. It was observed that 75 among these strains were free from rust, and appeared to breed pure for all the morphological characters studied ; they were about 10 to 15 days earlier in maturity than the old N.P. types under distribution. Yield data indicated that 30 of these strains were superior to the best among the recently evolved rust resistant N.P. strains and also N.P. 12, which was used as control.

From the F_2 progenies of crosses between N.P. R.R. 10 $\times$ Bolley Golden and N.P. R.R. 10 $\times$ Afghanistan 2, selections were made for early maturity, tiller number and yield.

Trials of 35 rust resistant strains (R.R. strains) were conducted at seven centres in five states of India (Bombay, Bihar, Delhi, Madhya Pradesh and U.P.). Observations show that at five centres, the R.R. strains, especially R.R. 38, R.R. 67, R.R. 204 and R.R. 5, ranked first and proved superior to the local controls. All the R.R. types maintained their immunity to rust at these centres.

Thirteen dual-purpose linseed strains were tested at five centres in five different states (Delhi, West Bengal, U.P., M.P. and Bihar) for their straw yield and seed yield. Some of the strains were found to be promising.

3. Safflower :

Periodical observations were recorded on the collection of safflower varieties, maintained at the Division, for their resistance to rust and *Cercospora*. All the strains of *Carthamus tinctorius* and *Carthamus oxyacantha* were found to be susceptible to the diseases caused by these fungal organisms but species like *C. lanatus* and *C. coerulens* were free from infection. Attempts were made to cross *C. lanatus* with *C. tinctorius* but there was no setting of seed.

4. Pigeon pea :

One hundred and twenty strains of pigeon pea, including 10 N.P. types, were tested for wilt resistance under conditions of artificial infection. Of these, 14 hybrids from the old crosses, and 31 hybrids from the new crosses and 1 Burma strain remained free from infection. As most of the wilt resistant strains are late maturing, some of them were crossed with an early maturing Brazilian strain with the object of introducing earliness into the N.P. types.

Eight wilt resistant varieties were tried at five centres in five different states and their performance was compared with local varieties. At three centres the wilt resistant types were found to be promising.

5. Chillli :

Seven pungent types of chillies were tested against local types at eight centres and five non-pungent types were grown for yield trial at Delhi. The results obtained from these trials at Delhi, were as follows :—

(A) Pungent types					(B) Non-pungent types						
Name of strain (in the order of merit)					Calculated yield of dry, ripe chillies (pounds/acre).	Name of strain (in the order of merit)					Calculated yield of fresh ripe chillies (pounds/acre)
N.P. 46A	..	..	..	..	1,887	R. 449	..	..	..	..	10,295
Hyb. 5-1-5	..	..	..	..	1,742	Bell pepper..	..	..	..	..	8,951
Hyb. 7-1-4	..	..	..	..	1,724	World Beater pepper			..	..	8,800
N.P. 41	..	..	..	..	1,633	R. 619	..	..	..	..	7,418
N.P. 34	..	..	..	..	1,343	R. 648	..	..	..	..	7,038
N.P. 51	..	..	..	..	1,143						
Local (Narela)		..	..	..	1,089						
Hyb. 17-1-1	..	..	..	..	944						

Sioux (575). *Desi* (540); *Prosperity* (539);

Hyb. 3 (433) and Local (464).

Forty samples of tomatoes were analysed for vitamin C and sugar contents. Hybrid 6 was analysed for vitamin C and sugar contents at different stages of ripening. It was found that sugar and vitamin C contents were highest at the fully ripe stage. It was further recorded that the sugar content of staked plants were higher (5.0 per cent) than that of unstaked plants (3.5 per cent).

Two selections, viz., 83 and 12-3-2 from crosses of *Lycopersicon peruvianum* with cultivated tomato, received from the U.S.A., were found to have high vitamin C content (58.8 and 55 mgm., respectively per 100 gm. of fresh material).

Several crosses between *Sioux*, *Desi*, Hyb. 4 and other varieties were studied in their F₂ generations. The cross between *Sioux* and *Desi* was considered important since a combination of several desirable characters, such as growth, hardiness and resistance to diseases, was noticed in the hybrid progeny.

8. Hybrid Maize :

This work is being done since 1946 under a scheme financed by the Indian Council of Agricultural Research.

Trial of promising material :

Results of three varietal trials of maize conducted during the year are summarised below :—

Out of 42 varieties included in the first trial, 26 were significantly early as compared to the control, Pusa Yellow 2. The earliest variety, "Golden Beauty", took 48 days for silking. Punjab type 43 was very late in maturity and took 64 days to silk. The control, Pusa Yellow 2, out-yielded all the others giving 2,577 lbs. of grain per acre.

The second trial consisted of 20 varieties with Pusa Yellow 2 as control. Kanpur T. 41 gave the highest calculated yield of grain per acre (3,227 lbs.). This and another variety, Meerut Yellow, have been multiplied for distribution to farmers around Delhi. In the third trial a variety from Rajasthan showed promise as an early and high yielding one.

Trials with foreign maize hybrids :

A number of foreign maize hybrids were tested in replicated yield trials at 14 centres in different states. Dixie 11 was amongst the first five in seven trials. Good performance was shown also by Dixie 22, Texas 26, Dixie 33, N.C. 27, U.S. 13 and Indiana 416B.

Five Canadian and four Australian hybrids were also tested at seven centres. In general, the Australian hybrids yielded better than the Canadian ones.

Study of hybrid vigour in maize :

Seven hundred and seven inbred lines in different generations of selfing were grown and 522 of them have been selected for further inbreeding.

The combining ability of a number of inbred lines derived from some Indian and foreign varieties, was determined in top crosses and in single crosses. The trials with single crosses indicated that crosses among inbreds derived from the same variety were inferior in yielding ability to those between inbred lines derived from different varieties.

CYTOLOGY AND CYTOGENETICS

Crop improvement through induced autopolyploidy :

The investigations on the problem of improving the seed fertility of colchicine-induced autotetraploids of some oleiferous *Brassicaceae*, sesame and linseed were continued. Observations on autotetraploid *toria* (*Brassica campestris* var. *toria*) indicated that the "mass-pedigree selection" method could further improve the fertility level of *elite* bulk populations grown in isolated plots. In a group of isolates, obtained from an *elite* bulk population, an increase of about 2.5 per cent, over the corresponding figures of the previous year in respect of the frequency of highly fertile plants in the population was noticed. Due to a severe hailstorm on the 1st March 1952, observations on other isolates of *elite* bulk populations which were expected to give more promising results, could not be made. The selection work will be continued next year.

Embryological investigations in some highly fertile and some poorly fertile autotetraploid plants of *toria* were taken up with a view to ascertaining the factors associated with seed sterility. A number of abnormalities were noticed in the behaviour of the embryo-sac and in embryo development.

As in the previous year, autotetraploids obtained from different rust resistant (R.R.) types of linseed were found to respond differently to polyploidy as regards the expression of characters such as gigantism and seed sterility. It was also noticed that meiosis in selfed, open pollinated and cross-pollinated progenies did not show any significant difference in respect of multivalent formation.

Interspecific hybrids of wheat (Triticum spp.) :

In the hexaploid hybrids of *T. vavilovi*, all the main ear characteristics except multinodal rachilla of *T. vavilovi*, were found to be dominant over the corresponding characters of the other parents, viz., *T. vulgare*, *T. sphaerococcum* and *T. compactum*. Inheritance studies on ear characters, like glume shoulder, beak and keel, in the F_2 generation of *T. vavilovi* $\times$ *T. vulgare* (var. C 591) were under progress. This study, as well as that of the fixed "off-types" which were derived originally from the other hexaploid hybrids of *T. vavilovi* and which were in the F_{11} generation, suggests that the expression of the character, i.e., multinodal rachilla, is influenced by environmental conditions.

An analysis of the F_2 population of the pentaploid hybrid, (*T. vulgare* $\times$ *T. pyramidale*) indicated a positive correlation between the number of chromosomes of the C-genome and the likeness of the segregates to *T. vulgare* in respect of a number of ear characters.

Some wheat species, like *T. monococcum*, *T. dicoccum* and *T. timopheevi* show a high degree of resistance to certain races of the wheat rusts. From the sterile triploid hybrid, *T. dicoccum* $\times$ *T. monococcum*, a fertile amphiploid was produced last year by colchicine treatment. This amphiploid is being studied cytogenetically as also from the point of view of its utilisation in breeding for rust resistance.

Intergeneric hybrids in Triticaceae :

A number of crosses, involving *T. vulgare*, *T. durum*, *Secale cereale* and some species of *Agropyron* were attempted for cytogenetical studies.

CROP PHYSIOLOGY

Study of drought resistance in wheat :

Experiments were repeated with the same fifteen varieties, as tested during the last season, both in the field and in pot culture. Intermittent drought was given in the pot experiment by reducing the frequency of watering (upto commencement of wilting) either throughout the life-cycle or at a later stage of growth (from the first week of

February onwards). In the field, the control plot received two irrigations, one on 21-2-52 and the other on 25-3-52, whereas the other plot received none. Moisture content of the soil at one-foot intervals up to a depth of four feet was determined from time to time and it appeared that some moisture stress developed in the unirrigated plot during the last three weeks of February and again in the last week of March. The overall reduction in grain yield, as a result of withholding irrigation, amounted to about 16 per cent. only, which was probably due to occasional showers of rain interfering with the continuity of moisture stress. The effect of interaction of soil moisture and variety on grain yield was statistically significant, thus indicating that the order of varieties in respect of grain yield differed under the two treatments. In spite of this significant interaction-effect, the Australian varieties, *Kendee*, *Ridley* and *Yalta*, maintained their superiority over all the other varieties in the irrigated as well as in the dry plot. The characters associated with their superior performance were : grain number per ear and 1,000 grain weight in *Kendee* and *Yalta* and ear number and 1,000-grain weight in *Ridley*. Similar results were obtained last season under pot-culture, and standard partial regression analysis of these, during the year under report, indicated that under adequate water supply grain yield was mainly determined by ear number, whereas under deficient moisture it is determined by ear as well as grain number (cf., Statistician's report).

Physiological analysis of factors concerned with yield :

Contributions of dry matter to grain from photosynthesis in the ear, leaf and stem varied as : ear, N.P. 710 > Pb. 9D=*Kendee* ; leaf, *Kendee*=N.P. 710 > Pb. 9D ; stem, N.P. 710=Pb. 9D=*Kendee*. The contribution from reserve material varies as N.P. 710 > Pb. 9D=*Kendee*. N.P. 710 and Pb. 9D have awned ears, whereas in *Kendee* the awns are few and very short. The number of spikelets in *Kendee* and N.P. 710 are almost identical, whereas in Pb. 9D it is definitely lower. These differences might in all probability account for the higher contribution by the ear of N.P. 710. The grain yield varied as N.P. 710 > *Kendee* > Pb. 9D, whereas the amount of dry matter assimilated during the post-anthesis period varied as N.P. 710=*Kendee* > Pb. 9D. This shows lack of correspondence between gain in dry matter and grain yield. On the other hand, grain number per ear varied as N.P. 710 > *Kendee* > Pb. 9D, thus showing good correspondence with the variation in respect of grain yield. It would seem that when the total assimilating surface (leaf, stem and ear) is intact and functioning normally, grain weight is largely determined by grain setting and as such, differences in yield as occasioned by environment and/or variety, must be associated with factors other than the amount of dry matter assimilated. If the photosynthetic surface is reduced (e.g., due to the infection of leaf-rust), it is obvious that grain yield would partly be determined by this factor. Detailed analysis, under way, of the data collected during the past five seasons, also points to similar conclusions.

Physiological aspects of plant nutrition :

In an experiment with three levels of nitrogen viz., 0, 20 and 40 pounds per acre and three varieties viz., N.P. 165, N.P. 710 and N.P. 52, it was found that N.P. 710 absorbed a larger quantity of nitrogen than the other two varieties. The yield per unit area of each of these varieties, however, remained the same. This finding is in conformity with the observations made during the last two seasons.

Plant Hormones :

Experiments on the effect of indoleacetic acid on wheat varieties, N.P. 165, N.P. 52 and C. 228 were repeated. The treatments, dipping cut tips of levels in solutions of 0 and 20 p.p.m. concentrations, were commenced five weeks after sowing and were continued for about 3 weeks. Another treatment consisted of spraying the plants with a solution of 200 p.p.m. of indoleacetic acid. In N.P. 52, the ear number increased under

20 p.p.m.; in N.P. 165, shoot number decreased under 20 and 200 p.p.m. and the grain number increased and the 1000-grain weight decreased under the latter concentration.

In another experiment with three varieties of wheat viz., N.P. 52, C. 228 and N.P. 165, the effect of application of 2, 4-D (2.5 mg. per pot) to soil at three different stages was investigated. The stages were : completion of double ridges, appearance of boot-leaf and ear emergence (main shoot). Another treatment consisted in spraying the ear with a solution of 10 p.p.m. 2, 4-D after anthesis. The treatments adversely influenced the growth and yield of N.P. 165 whereas the same treatments did not produce any adverse effect on N.P. 52, and C. 228. The nitrogen content of the grain increased under some treatments and decreased under others, in the case of all the three varieties, and this variation did not show any relationship with grain yield.

Weed control :

In a field experiment (crop : wheat) involving the comparison of hand weeding with the use of weedicides, it was found that the weedicides (viz., Sodium salt of 2, 4-D, ester of 2, 4-D and methoxone) were practically as effective as a single operation of weeding by hand. Among the three weedicides used, it was noticed that on the whole, 2, 4-D preparations were more effective than methoxone. The dominant weeds in the experimental field were :—*Anagallis arvensis*, *Melilotus alba* and *Chenopodium album*. The effect of weeding on the yield of wheat could not be assessed due to the serious damage caused by the hailstorm in March.

A specially sown plot of *Carthamus oxyacantha*, (*pohli*), was sprayed with the above three weedicides on the 17th, 66th and 106th day after sowing. A complete kill was obtained in the case of spraying on the 66th day, while those plants which were sprayed after 106 days (i.e., at the flowering stage) did not show any effect.

Lodging in wheat :

An experiment was conducted with three varieties of wheat viz., N.P. 52, N.P. 710 and N.P. 165 using different quantities of nitrogen and different times of their application. It was observed that upto the end of February, the extent of lodging was found to be the least under no nitrogen and also when nitrogen was applied 70 days after sowing.

In another experiment with three varieties of wheat viz., N.P. 12, C. 518 and N.P. 165 and, with two levels of nitrogen viz., 0 and 80 lbs. per acre, it was observed that nitrogen depressed root growth in C. 518 to a relatively much smaller extent than it did in the case of the other two varieties. Nitrogen application did not also raise the nitrogen content of the lowest internode to the extent it did in the case of two varieties. The silica content of the lowest internode was the highest in C.518 Nitrogen also decreased the development of the mechanical tissue and increased the moisture content and the length of the internode.

SYSTEMATIC BOTANY AND PLANT INTRODUCTION

As in the previous years, a considerable amount of advisory work dealing with botanical names and identification of plants was attended to in the section of Systematic Botany. A preliminary study of a few jute varieties was under way in respect of the variation in morphological characters in them and their adaptability to Delhi conditions. It was found that, under irrigation, types I.C. 326 and I.C. 327 of *Corchorus*

olitorius and I.C. 328 and I.C. 329 of *C. capsularis*, gave good performance at Delhi. The general height attained by plants as indicated by the length of the fibre of these varieties during the past two years of trial is given below :—

Species	Type No.	Length of fibre in inches	
		(1950-51)	(1951-52)
<i>Corchorus olitorius</i>	I.C. 326	108	117
	I.C. 327	86	114
<i>Corchorus capsularis</i>	I.C. 328	84	98
	I.C. 329	78	98

Seed production in these jute varieties appeared to be better under the comparatively dry conditions of Delhi, than elsewhere; thus, as against the average yield of 3.5 to 4 maunds of seeds obtained per acre in Bengal, the types grown at Delhi gave a calculated yield of 6 to 6.5 maunds per acre.

Weed survey :

A general survey of weeds of cultivated fields was done with the object of studying the succession of weeds throughout the year. The dominant weeds during the *Kharif* (July-August) were *Conyza ambigua*, *Heliotropium eichwaldi*, *Euphorbia hirta*, *Digera arvensis* and *Tribulus terrestris* and those during the *rabi* (January-February) were :—*Chenopodium album*, *Chenopodium murale*, *Fumaria parviflora*, *Anagallis arvensis*, *Sisymbrium irio*, *Argemone mexicana* and *Trigonella polycerata*.

Seed production and viability of seeds was studied in the Mexican poppy (*Argemone mexicana* L.). The number of capsules produced on single plants, varied between 38 and 146, the average being 77. The average number of seeds per fruit was 591. Thus, one plant was capable of producing on an average, 45,507 seeds. Seeds from capsules at different stages of maturity were tested for their germination capacity. It was found that the percentage of germination increased with the maturity of the capsules; while seeds from one-month-old capsules did not germinate those from 40 and 50-days-old capsules, gave 50 and 60 per cent germination respectively and seeds from 60-days-old capsules gave a cent per cent germination.

Plant Introduction :

During this year, 1,355 samples of seeds were received from foreign countries and 457 samples of seeds were sent out to various experimental stations in India and abroad. The more important results obtained are summarised below :—

(1) In further trials, the Chinese sweet-potato varieties, F.A.17 White and *Tie Shin Tun* gave tuber yields of 395 and 225 maunds, respectively per acre as against about 60 to 70 maunds obtained from the local types grown as controls. The American sweet potato variety, Golden Skin Yam, gave a good performance under Indian conditions with an yield of about 155 maunds per acre; this variety was found to be very rich in carotene-content (42.8 p.p.m.) and is more nutritious than others (average of 0 to 3 p.p.m.). Demand for the propagating material of these improved varieties of sweet potato increased greatly and, during the year under report, about 50,000 cuttings were distributed to growers in Delhi, U.P., Rajasthan, Punjab and PEPSU.

(2) Amongst the miscellaneous collections, mention may be made of 12 samples of *Pyrethrum* seeds and oyster nut (*Telfaria pedata*) obtained from Japan and Rhodesia respectively. Several varieties of the Mesquite bean (*Prosopis juliflora* and *P. pubescens*), well known for growing in drought-affected and arid regions, have been

received from the U.S.A. Some of the East African varieties of Italian Millet (*Setaria italica*) were again tried in Himachal Pradesh. The yield of one of them, E.C. 1748, was about 45 per cent more than that of local types. Two American varieties of garden pea viz., Early Badger and Delwiche Commando, were tried at Delhi and were found to be very early. A Canadian variety of mangel (Can. 5166) produced large roots, some of which weighed 12 to 14 pounds. Some sugar beets grown from imported seeds did well at Delhi; sugar content in them was found to be as high as 15.3 to 15.6 per cent.

(3) Work on the introduction, selection and study of fodder plants was continued. A species of vetch (*Vicia sinkiangensis*) recently received from Australia, gave a good performance at Delhi and it was the only species which remained green until the middle of May. A Cyprus variety of *Vicia sativa* produced good quantity of seeds. The creeping indigo (*Indigofera endecaphylla*) from Ceylon, continued to grow well and in view of its quick and dense mat-like growth, it is considered suitable for soil conservation. It also appears to be good for fodder possessing a protein content as high as 12.25 per cent. The Brazilian grass, *Bothriochloa insculpta*, was chemically analysed and was found to compare favourably, in nutritive value, with Rhodes grass.

ADVISORY

About 175 items of advisory nature were dealt with during the year. They were as follows :—

Identification of plant specimens, wild fruits and seeds ...	...	63
Supply of correct botanical names or vernacular names of plants with notes on their uses ...	...	92
Notes on the cultivation of specific crops ...	...	10
Miscellaneous notes ...	...	10
Total		175

Some of the interesting items of advisory work done are mentioned below :—

- (a) Weed seeds collected from a sample of imported wheat were found to contain seeds of the cockle (*Lychnis githago*) which are very poisonous.
- (b) Ten desert plants were identified for Dr. Ivanhoff, a Russian entomologist, who visited India in 1951.
- (c) Two herbarium specimens of the weed *Kochia indica* and a sample of its seeds were sent to Professor D. Thoday of Egypt.
- (d) Botanical names of 25 desert plants were given to the Soil Survey Officer, Hirakud Dam Project, Hirakud.
- (e) Information regarding cultivation of camphor was given to Mr. R. S. Malik of Najafgarh Road, Delhi.
- (f) Botanical names of 16 oil yielding plants were supplied to the Assistant Marketing Officer, New Delhi.
- (g) Herbarium specimens of wheat and allied species were prepared and sent to the Delhi University, Delhi.
- (h) About fifty herbarium specimens of common weeds and grasses of cultivated fields were prepared and sent to the Janta College, Alipur, Delhi.

BOTANICAL SUB-STATION, PUSA

This Sub-station, maintained at Pusa, Bihar, continued its work under the general supervision of the Botany Division. The season, on the whole, remained dry ; as against the normal annual rainfall of 50", the precipitation during the year was only 25.1".

The main items of work undertaken at the sub-station include (i) maintenance of valuable crop collections, and performance trials of certain types under Bihar conditions, (ii) breeding of better plants especially wheat, linseed and pigeon pea, and (iii) multiplication of foundation stocks of improved N.P. types for distribution to the farmers in that part of the country.

Work on the Permanent Manurial and Rotational Experiment and on the New Manurial Experiment was conducted for the Agronomy Division. In Series A, maize was planted during the *kharif* and it was followed by barley during the *rabi*. In Series B, maize and *rahar* (pigeon pea) were planted in *kharif* and *rahar* in *rabi*. In the New Manurial Experiment, maize was grown during *kharif* and was followed by gram in *rabi*.

The wheat crop was badly affected by black and brown rusts. In the wheat trial, the performance of the 14 N.P. varieties was more or less similar to that in the previous year.

Small scale trials of brinjal (*Solanum melongena*) and tomato was conducted. Of the four brinjal types (Lancaster Black, Black Large Round, *Muktakeshi* and the local), *Muktakeshi* yielded 20 per cent more than the local, while the other two yielded very much less. Trials with tomato indicated that Hybrid 2 and Hybrid 8 gave yields about six times as much as that given by the local types.

Supply of pure seeds formed an important part of the work of this Sub-station. The maximum demand for seeds was for those of N.P. wheats, over 7,500 lbs. having been distributed during the year. Other seeds which were distributed were those of paddy, gram, *rahar*, lentil, linseed, *Hibiscus*, tobacco, barley, oat, pea, mung and urid.

Programme of work for 1952-53

1. Improvement of wheat with special reference to resistance to rust and for higher yield.
2. Conducting trials of recently evolved improved varieties of crop plants such as wheat, linseed, tomato, sesamum, etc., in the different states.
3. Investigations on the utilisation of hybrid vigour in maize.
4. Induction and study of polyploidy in crops like *Brassica*, linseed, sesame and gram as a method of crop improvement and trial of some of these polyploids.
5. The study of wild relatives of crop plants and their utilisation in breeding superior varieties for the future.
6. Improvement and application of various cytological techniques.
7. Cytogenetical studies of *Triticum*, *Agropyron*, *Secale* and of some interspecific and intergeneric hybrids.
8. Studies on drought resistance in wheat.
9. Physiological analysis of factors concerned with yield.
10. Plant hormones : investigations on the role of different hormones on growth and development of wheat and their usefulness in controlling weeds of cultivated fields.
11. Influence of light and temperature on development and growth : raising more than one generation of wheat crosses.
12. Physiological aspects of plant nutrition : studies on the relation between varietal differences in the uptake of nutrient.
13. Lodging in wheat : investigations on factors concerned with lodging.
14. Systematic classification of varieties of crop plants like sweet potato, oleiferous *Brassicae*, sesame, etc.
15. Study of weeds and their succession in crop fields.
16. Plant introduction, collection of exotic plants and their maintenance.
17. Trials of crop collections like those of hybrid maize, sweet potato, etc. in Delhi and in the different states.

REPORT OF THE DIVISION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY FOR THE YEAR 1951-52

(Dr. S. P. Raychaudhuri)

I. SOIL CHEMISTRY

(a) Agricultural Chemistry

1. Fertilizer value of dicalcium phosphate :

Investigations on the relative fertilizer values of dicalcium phosphate (prepared by the National Chemical Laboratory, Poona) and superphosphate were carried out. Laboratory seedling tests with maize showed that 92.6 per cent of the added phosphate of the former and 86.4 per cent in the case of the latter were taken up by the seedlings. Pot culture experiments with wheat showed that the yield of wheat grain was increased by 77 per cent in the case of dicalcium phosphate and 32 per cent in the case of super. Field trials with paddy are now in progress.

2. Wild leguminous plants as green manure :

Investigations on the utilisation of wild legumes were continued during the year under report. *Kharif* field experiments with maize crop green manured with leaves of *Prosopis juliflora* and *Tephrosea purpurea* gave significant increase ranging from 128—210 per cent over control. Seeds of wild leguminous plants were found to contain from 3 to 6 per cent N besides substantial amounts of P and K and thus offer possibilities of their utilisation as manure.

3. Utilization of some waste nitrogenous materials as manures :

Large quantities of waste materials like wool waste, hair wastes from tanneries, slaughter house wastes, horns, hoofs, etc., at present find little use in the country as manures in spite of their high nitrogen content of over 10 per cent because of the low availability of this nutrient. Treatment with steam under a pressure of 25 lb. for 2 hours and subsequent drying rendered the materials powderable and increased the nitrogen availability, as shown in nitrification tests, and gave 50 to 60 per cent increases in the yields of wheat grain in pot experiments. Treatment of wool and hair wastes with 10 per cent alkali and subsequent neutralization with mineral acid gave a manure of high nitrogen availability.

4. Studies on chemical composition of crops :

Studies on the inter-relationships between major inorganic elements (N, P, S, Si, Mg, Ca and K) that comprise the chemical composition of plants when expressed in milli-equivalents show that (a) the cation/anion ratio tended to remain constant (about 0.2) in all seeds irrespective of species (b) this ratio varies with the stage of growth but is constant for each species of plants at any stage. Although manuring was found to alter the uptake of individual constituents, there was a relative adjustment so as to maintain the above relationship. The utilization of these for practical application to improve the quality of crops is under further investigation.

5. Effect of free phosphoric acid and moisture on the physical condition of super-phosphate and rotting of bags :

At the instance of the Indian Standards Institute, experiments were undertaken to examine the effect of varying contents of free phosphoric acid and moisture in super-phosphate on its physical condition and rotting of bags.

The results so far obtained show that free phosphoric acid to the extent of 2—5 per cent had little rotting effect on jute bags. Between 6—8 per cent free acid, the damage to bags was apparent by the weakening of the fibre which would not stand rough handling during transport. Beyond 8 per cent free acid, the damage was severe and the bags visibly gave way.

6. Effect of pretreatment of seeds in nutrient solutions on crop growth :

The effect of soaking seeds in nutrient solutions prior to sowing has been reported to be beneficial for subsequent plant growth and has been suggested as a means for economising fertilisers applied in comparatively large doses to soil.

Pot experiments were undertaken to test this treatment along with soaking in milk and in a decoction of indigenous drugs, as suggested by the Ministry of Agriculture. It was found that mere soaking of seeds in 0.5 molar solutions of ammonium nitrate, ammonium phosphate and potassium phosphate would be insufficient to meet the requirements of crops for the major nutrients that may be deficient in soils and the treatment cannot entirely replace direct manuring of soil. Differences in yield under

the different treatments, however, indicated that presoaking in ammonium phosphate may prove beneficial, to the extent of about 20 per cent at least. Further trials on the effect of presoaking as a supplementary treatment to manuring at different levels are under study.

Treatment of seeds with milk and drug decoction had no beneficial effect either on the yield or on drought and disease resistance. The latter two aspects were examined by the Botany and Mycology Divisions, respectively.

(b) Soil Chemistry

7. *Studies on the use of 8-hydroxy-quinoline in direct estimation of Fe, Al, Ca, and Mg :*

Estimation of Fe, Al, Ca and Mg from a solution involves a lengthy series of precipitations, filtrations and titrations. It was observed that a simpler process could be adopted. The precipitation of Ca, Mg and Al could be carried out separately from the same solution by 8-hydroxy-quinoline by adjusting the pH of the medium to values ranging from 6.5 to 8.5.

8. *Mineralogical make up of Indian soils and its relation to base exchange reactions :*

Buffer curves were prepared for 20 soils—and in some cases for their clay separates and were compared with those prepared for some typical clay minerals.

The curves for the soils were typical and characteristic of the predominant clay minerals present, exhibiting sharp inflections at pH 4.6 and 9.8. The curves could be used for determining values for acidity, adsorption and buffer capacities. These factors were found to be specifically inter-related so that a change in one of them influenced the others quantitatively. The buffer value of soil was different at different degrees of saturation and this property was attributed to the nature of clay mineral present.

9. *A study of the saline and alkaline soils of the Delhi State :*

14 surface samples and a profile collected from the village Nangloi were examined for different physical and chemical characteristics. It was observed that the soils varied in the degrees of alkalisiation and on the basis of the same, a classification of the soils could be made. The classification suggested, is expected to offer methods of better utilisation of the lands for agricultural uses, their conservation and reclamation.

10. *Action of tank silts on soils :*

It was generally believed that the beneficial effects of tank silts were due to improvement in the physical conditions of the soil. The manurial value of the nitrogen content of the silts was generally ignored since it was very low as compared to the nitrogen content of common fertilisers and manures.

Nitrification experiments with some tank silts from West Bengal showed that the silts contained easily nitrifiable nitrogen. There were some initial losses of nitrogen from the soil-silt mixtures but they were soon made good by high nitrogen fixation which alone could account for the remarkable residual effects of the same.

11. *Work at the Botanical Sub-station, Pusa (Bihar) :*

(a) *Lysimeter investigations :*

The four lysimeters (drain gauges) were brought under cultivation after 16 years. The cropping scheme was the same as that followed during the years 1911-34 namely :—

Lysimeter No. 1 (Depth 6 ft.)—Only wheat unirrigated.

Lysimeter No. 2 (Depth 6 ft.)—Sannhemp removed at flowering followed by wheat.

Lysimeter No. 3 (Depth 3 ft.)—Bare fallow.

Lysimeter No. 4 (Depth 3 ft.)—Sannhemp to maturity.

(b) Raised plat studies :

The twelve raised plats in Southern Trial Grounds (area 1/1,000 acre, depth 3 ft. each) were filled with fresh soil from a neighbouring plot and sown to a general crop of sannhemp which were ploughed in after about 8 weeks. The yields of above ground green matter in the 12 plats were fairly uniform (about 25,000 lb. per acre). In the following *rabi*, a general crop of wheat (NP 165) was grown under irrigation and in this case also the yield was fairly uniform.

(c) Field plat studies :

The nine field plats adjacent to the raised plats were cropped with maize during the *kharif* and berseem-barley during the *rabi* season under irrigation. It was decided to follow a 2 year—4 course rotation in the plats.

(d) Permanent manurial experiments :

Chemical analyses of soils, crops, manures and fertilisers were carried out in connection with these studies. The yield of the above ground green matter that was ploughed in the green manured plots was estimated to be about 12,000 lb. per acre in the unmanured plot, but when fertilised with super at the rate of 80 lb. P_2O_5 per acre the yield was about 21,000 lb. per acre. Nitrogen, in both cases was about 0.5 per cent on fresh basis, so that the amount of nitrogen ploughed in as organic matter in the phosphate treated plot was about $1\frac{1}{2}$ times as much as that added to the untreated plot.

(c) Soil Fertility

12. Building up of soil fertility by the phosphatic fertilization of legumes :

(i) *Lysimeter experiments* : The crop yields obtained in the *rabi* 1951-52 season show that the introduction of unmanured berseem in the rotation more than doubled the yield of the succeeding wheat crop, as compared to the unmanured cereal rotation of wheat and *bajra*.

(ii) *Top Block 3A Field Experiments* : The crop yields of the *rabi* 1951-52 season show that the yield of wheat after berseem is about double the yield obtained in a cereal rotation of wheat and *bajra*.

13. Compost experiments :

(i) Comparison of different methods of manure preparation :

A comparison of (a) plastered trenches, (b) overground heaps and (c) exposed pits, showed that overground heaps yield manure of wide C/N ratio, due to rapid drying out and incomplete decomposition. In exposed pits, nearly 40 per cent of the total nitrogen and 60 per cent of the organic matter were lost. Plastered trenches gave the highest recovery of manure and nitrogen.

(ii) Destruction of weeds during compost-making :

When counted numbers of seeds of the *rabi* weeds viz. : (a) *Vicia hirsuta*, (b) *Vicia sativa*, (c) *Medicago denticulata* and (d) *Lathyrus aphica* were composted with cattle shed refuse, (a) and (c) were destroyed upto 90—95 per cent of the total number while, (b) and (d) were destroyed upto 75—80 per cent only. Most of the destruction occurred during the first month of composting, when temperatures went upto 50—60°C. indicating that temperature was the main factor in the destruction of the weed seeds.

14. *Influence of growing legumes on the chemical and microbiological properties of the soil, with special reference to berseem :*

Chemical and microbiological analyses carried out on soil samples taken from differently treated plots in Top Block 3B where a berseem rotation has been followed for the last 10 years, showed that the plots where berseem had been grown with phosphate application possessed a significantly higher content of organic matter, organic nitrogen and nitrate nitrogen and also possessed higher ammonifying, nitrifying and nitrogen fixing powers than plots where no berseem had been grown or where berseem had been grown without phosphate application.

(d) *Micronutrient elements*

15. *Work on gram : (Cicer arietinum) :*

Top yellowing of gram : Pot culture experiments with soils from (1) healthy area, i.e., where no top yellowing was observed in gram grown in the previous season (2) diseased patch, i.e., where top yellowing was observed and (3) Salt patch i.e. where definite white salt incrustations were noticed, in Main Block 5E, were conducted. These soils contained 0.12, 0.15 and 0.3 per cent soluble salt respectively. There was no difference in pH which was around 7.5. The treatments were : (i) control i.e. soil from healthy area, (ii) soil from healthy area but with a water table at 10" below the surface, (iii) soil from healthy area but with 0.08 per cent salt to give a total soluble salt concentration of 0.2 per cent, (iv) soil from diseased patch, (v) soil from diseased patch but with a water table at 10" and (vi) soil from salt patch.

The water table treatments were given by placing the pots in a pan where water level was such that it could just cover the drainage hole at the bottom of the pots. Water table and salt (of about the same composition as found in the fields) treatments were given when the plants had established themselves. After about a week typical top yellowing symptoms started appearing only in plants in the two series of pots where water table treatments were given. Plants in other pots were perfectly healthy though later on plants in the series of pots which had soil from the salt patch or had the 0.2 per cent salt, started showing salt injury and dying. When Top yellowing symptoms had fully developed, the water table treatment was removed by draining the pans containing water and gradually the symptoms disappeared. This corroborated the previous year's finding. 'Top yellowing' in gram is, therefore, concluded as due to air-water unbalanced in the root-zone of the crop. The reducing conditions prevailing under the above conditions lead to more absorption of iron with consequent less uptake of manganese.

16. *Trace elements in grasses, forages, concentrates, etc. :*

Pot culture experiments with *Phalaris minor* and Sudan grass on Delhi farm soil were conducted to study the uptake of micronutrients by these grasses under different fertilizer treatments. From the figures of the 1st cutting of the grass it is observed that both ammonium sulphate and superphosphate definitely promoted higher absorption of copper. Lime and muriate of potash did not seem to have much effect on the content of copper as compared to control. Cobalt uptake was enhanced with all the treatments. Both ammonium sulphate and superphosphate depressed the uptake of manganese over control but lime increased it. Comparing Cu and Mn contents there was apparently an antagonistic relation between these two elements and wherever copper content was high Mn was low and *vice versa*. In 2nd cutting, fertilizer effects on the absorption of micronutrients were, in general, inappreciable, though reduced uptake of manganese was still noticed with ammonium sulphate and superphosphate. K₂O, CaO, MgO, P₂O₅, Cu, Co and manganese have been estimated in Sudan grass treated differently. Ammonium sulphate reduced the contents of all the nutrients analysed. Other fertilizer treatments had practically no effect.

17. *Micronutrients status of Indian soils :*

Soil collected from the artificial NPK treated plots of the permanent manurial series of the Botanical Sub-station, Pusa, was tested for micronutrient deficiency by

growing *marua* and berseem crops in the pot cultures. Micronutrients were applied as spray at standard spray doses at two stages of growth in the life cycle of plant. Growth observations on tillers and height were made. Grain yield at harvest has been statistically analysed. The results are as follows :

Treatments	NPK	NPK plus Mn	NPK plus Zn	NPK plus Cu	NPK plus B	NPK plus Mg	NPK plus Fe	NPK plus all
Mean grain yield in gm. per pot.	10.88	21.40	24.53	24.72	25.33	24.28	29.03	19.98
		F test significant at 1%.						
		C.D. at 1% = 10.61 gm.						
		C.D. at 5% = 7.80 gm.						
Conclusion at 5%	7	5	4	3	6	2	8	1

All the micronutrients increased the yields over control but iron and boron more than others.

18. *Work on citrus* : (Scheme of Research on Minor or Trace Elements in Indian Soils & Plant Nutrition financed by I.C.A.R.) :

At Tharsa (M.P.) a few trees, and at Ubali (M.P.) most of the trees were found to be affected with mottling of leaves. The soils of Ubali and Tharsa are highly alkaline, contain carbonate and have a high clay content. Calcium content in these soils was also high. Phosphate in soils of Ubali was much higher than those at Tharsa. Tharsa soils are, however, richer in the contents of potash compared to those of the Ubali soils. Analysis of the leaf samples of Nagpur Orchards show that diseased leaf samples from Ubali Orchard have a much lower content of iron as compared to the healthy ones, pointing to a possible deficiency in iron. In both Ubali and Tharsa farms diagnostic injection and spray treatments with micronutrient solutions (B, Cu, Fe, Mg and Zn) were conducted. The results are awaited.

II. SOIL PHYSICS

(1) *Ley farming*, (2) *Cultivation and manurial treatments on moisture conservation and soil aggregate studies* :

It was recorded that the introduction of grasses has been definitely beneficial both in moisture conservation and in better soil aggregation formation. An increase of 1.0 per cent to 3.0 per cent moisture due to grasses during the initial stage and 3.0 to 6 per cent under maize-wheat rotation was noticed. Addition of inorganics did not show any advantage with respect to moisture retention capacity of the soil. Appreciable amount of soil aggregation occurred in presence of grasses, being 30 per cent to 32 per cent aggregation as against a meagre aggregation of 7.4 per cent in absence of grasses.

III. PHYSICAL CHEMISTRY

1. *Electrochemical and mineralogical properties of hydrogen clays from typical Indian soils* :

Studies of the electrochemical and mineralogical properties of hydrogen clays prepared from horizon samples of typical soil profiles from different localities, for gaining information on the development and genesis of these soils were continued. During the year under report the following profiles were studied :—

(a) Saline soil from Lucknow.

(b) Saline soil from Delhi.

(c) Black cotton soil from Bhopal.

(d) Black Kanhar soil from Labhandi (M.P.).

(e) Soil of Rann of Cutch.

(a) *Saline soil from Lucknow* : The soil lies in the usar tract of the Uttar Pradesh, the total soluble salt varying between 0.16 per cent in the top horizon to over 1.4 per cent in the lower layers. The nature of the potentiometric titration curves of hydrogen clays from different horizons, with NaOH and $\text{Ba}(\text{OH})_2$, and the value of the base exchange capacity which varies between 29 and 35 m.e. per 100 gm. clay suggest that illite and kaolinite are the predominant minerals in these clays. This is supported by the presence of non-exchangeable potassium to the extent of 3.2 to 4 per cent K_2O and of magnesium amounting to 1.5 per cent MgO in the H-clays. $\text{SiO}_2/\text{R}_2\text{O}_3$ and $\text{SiO}_2/\text{Al}_2\text{O}_3$ ratios are about 2.6 and 3.4 respectively. There is very little variation in the viscosity of the clay suspension with increasing base saturation with NaOH. Adsorbed water is about 4 per cent and the crystal lattice water 6.5 to 7.6 per cent.

(b) *Saline soil from Delhi* : (Madanpur Khadar) : The nature of the potentiometric titration curves of the hydrogen clays from different horizons, with NaOH and $\text{Ba}(\text{OH})_2$, both of which show low initial buffering, and the value of the base exchange capacity, which varies between 16 and 18 m.e. in case of NaOH and is about 17 m.e. per 100 gm. in case of $\text{Ba}(\text{OH})_2$, suggest that illite is a predominant mineral in these clays along with kaolinite. This is supported by the chemical composition, electroviscous properties and thermal dehydration of these clays. $\text{SiO}_2/\text{R}_2\text{O}_3$ and $\text{SiO}_2/\text{Al}_2\text{O}_3$ ratios vary respectively between 2.2 and 2.5 and between 2.9 and 3.1. Non-exchangeable potassium is present to the extent of 4.1 to 4.6 per cent K_2O and magnesium to the extent of about 1.3 per cent MgO. There is no variation in the viscosity of the clay suspension with increasing addition of NaOH. Adsorbed water is about 2-3 per cent and crystal lattice water 6.3 to 7.0 per cent.

(c) *Black cotton soil from Bhopal* : The upper horizon of the profile upto a depth of 250 inches was black in colour, below which was red. Electrometric titration of H-clays prepared from different horizons shows strong monobasic acid character of these clays. The base exchange capacity is high, varying, between 50 and 76 m.e. per 100 gm. clay and reflect montmorillonitic nature of the mineral throughout the profile.

(d) *Black Kanhar soil from Labhandi* (Madhya Pradesh) : The potentiometric titration of the H-clays with baryta shows strong monobasic acid character. This together with high value of the base exchange capacity, which varies between 82.5 and 95.0 m.e. per 100 gm. indicate that the dominant clay mineral is montmorillonite. This is supported by the rise in viscosity of the clay suspension with increasing addition of NaOH, which passes through a maximum at about 75 per cent neutralisation and then falls. $\text{SiO}_2/\text{Al}_2\text{O}_3$ ratio is 4.0 to 4.2.

(e) *Soil from the Rann of Cutch* : The clay mineral consists mainly of illite as judged from the weak monobasic acid character of the H-clays from potentiometric titration with baryta, the value of the base exchange capacity and also from the fact that there is no variation in the viscosity of the clay suspension with increasing base saturation.

2. Displacement of hydrogen and aluminium ions from hydrogen clay on repeated neutral salt treatment :

Hydrogen clay prepared from bentonite, known to be pure montmorillonite was repeatedly leached with N BaCl_2 followed by desaturation with 0.02 N HCl. The hydrogen clay thus regenerated was again leached with the salt solution. The whole sequence of operation was repeated many times. In each leachate the total acidity

and the aluminium content were estimated. It was found that there was a limit to the amount of acid which could be displaced on repeated leaching of the H-clay with BaCl_2 . In any desaturation the amount of displaced aluminium ions decreased with the progress of leaching to a negligible value, showing that there was a limit to the amount of aluminium ions which could be displaced from a hydrogen clay on repeated salt treatment. But as often as the clay was rendered unsaturated and then treated with neutral salt, aluminium ions were liberated, although its amount was considerably reduced after the first desaturation. Repeated salt treatment and desaturation caused some decomposition of the clay complex, as evidenced by the lowering of the base exchange capacity from 56 to 40.8 m.e. per 100 gm. clay.

IV. SOIL SURVEY

1. Black soil of Bhopal :

In connection with the soil survey of Bhopal Sugar Factory, Sehore a large number of profiles were examined and analysed of which two black soil profiles and one red soil profile were taken for detail study to find their genetic relationship as far as possible. Besides chemical analysis of clay the electrochemical methods for identification of clay minerals were also adopted. The fine sand fraction of mechanical analysis was also compared with the mineralogical analysis of disintegrated rock samples found under these soils. These results and also other studies carried out in black soil profiles, the brown layer which frequently occurs in the B horizon and the red-brown soil occurring frequently with black soil are genetically of the same origin. The basic minerals present in the brown horizon are much less as compared with those of black horizon indicating thereby that brown layer of red soils are more weathered and advanced in maturity. It may thus be suggested that black soil on continued weathering gives rise to the brown, yellow and red soil, the montmorillonites decomposing into the kaolinites during the weathering process.

2. Reconnaissance soil survey of the commanded area of Chambal Hydel project in Rajasthan :

Thirty test profiles were dug up to a depth of 8 to 10 ft. from the surface and the morphological examination was carried on. Besides these profiles five newly dug up wells which were excavated to a depth varying between 20 and 30 ft. were also examined. The total soluble salt was between 0.07 and 0.12 per cent. The pH value was between 7.2 and 8.3, which indicated the presence of free carbonates of calcium, magnesium or both. The carbonate content of these soils vary between 0.1 and 10.7 per cent (10.75 was found only where the accumulation of *kankar* was in large bands) indicating thereby that soils are not deficient in lime. The moisture holding capacity of these soils vary between 30.0 and 59.0 per cent and indicate the clayey nature of soil. Exchangeable sodium was found to be negligible in most of the samples studied :

3. Soil Survey and Land Use Survey of Bhangar area in Delhi District, Gheora Village :

The morphological features of the soil profiles in the canal irrigated, well irrigated and rain fed areas are very similar except for the distribution of calcium carbonate and iron concretions. The soils of the village are classified as Gheora series with two types and two phases. The characteristics of the series are :

A—Yellowish brown sandy-loam to loam of neutral reaction with no CaCO_3 .

B—Slightly heavier textured. Yellowish brown loam. Mildly alkaline with small sized iron concretions and no CaCO_3 .

C—Yellowish brown loam alkaline with CaCO_3 in the lower depths of the horizon.

The land was classified into five classes based on their production capacity.

A soil and land use survey of villages in the *Dabar* areas is in progress. The soils in this area are grouped under Gheora series. Saline and saline-solonic soils are noticed in this tract.

4. Soils of Rann of Cutch :

The presence of large amounts of gypsum in these soils offered considerable difficulties in dispersing the soils for mechanical analysis by the International Method. Preliminary boiling of the soils with sufficient quantities of sodium carbonate and destroying the precipitated calcium carbonate with dilute hydrochloric acid proved to be rapid. The analysis of the surface and subsurface soils for their nutrient status showed that nitrogen, phosphorus and potassium are in sufficient quantities. In some cases high amount of phosphorus has been noticed and a microscopic examination of the sands showed the presence of apatite in these soils. The acid clays separated from these soils contained high amounts of potassium and the electro-chemical properties determined in the physical chemistry section showed they are mostly illitic in nature. Sulphate reducing organisms are found to be present in the soil profiles, but their activity in the different horizons is not consistent.

5. Topographical survey & cartography :

At Karnal a contour survey was carried out for laying down the supply water channel from a tube well.

(ii) Topographical survey of the Moghal canal at Okhla was carried out and contour of one foot interval was marked.

(iii) Contour bund was prepared at Qamaruddin Nagar on a slope of 1 to 3 per cent.

6. Mineralogical studies :

(a) Black & associated red-brown soils of India :

Mineralogical analyses of fine sand fractions of soils collected at Padegaon, Bhopal, Nagpur, Raichur, Hagari, Nandyal, Coimbatore and Koilpatti were carried out. All these soils show common occurrence of a group of minerals, viz., pyroxene, hornblende, garnet and hypersthene which belong to basic rocks of South India. The indications are that the associated red-brown soil of Padegaon and Bhopal are the results of prolonged weathering of basalt.

(b) Red and lateritic soils of Bihar :

These soils show dominance of magnetite and titanium bearing minerals in the heavy fraction of the fine sand fractions indicating probably basic parent material (basaltic).

(c) Rann of Cutch :

Further heavy mineral analysis of profiles from little Rann of Cutch was carried out. Profiles of Nanda and pit No. 8 on the main land of Cutch are mineralogically similar, while profile No. 4 also on the main land is not similar to either of them. Ratio of zircon and augite in these profiles in such a manner as to suggest, that either weathering or difference in source material is the reason for the differences between these profiles.

Roundness studies of gravels and of zircon indicate a bimodal origin of profile 4 and a contrast between the conditions of deposition of the mainland samples (Pit 4 and 8) and Rann samples (Nanda).

(d) *Delhi soil :*

Further evidence of the aeolian origin of the western soils were obtained. The degree of sorting of these soils (0.67) compare well with those of loess (0.34-1.49). Delhi rocks contain 93.6 per cent silica, in contrast to much lower figures in the soil. The geological history of the sediments of Delhi was worked out.

V. ORGANIC CHEMISTRY

1. Oils, fats and oilseeds :

(a) *Detection of adulteration of ghee :*

Using ethyl ester of tyrosine in concentration of 0.1 per cent in hydrogenated fat, it was found possible to detect the presence of hydrogenated fat in buffalo or cow ghee when it is present in the proportion of 3 parts of hydrogenated fat for every 100 parts of clarified butter.

(b) *Determination of the quality of oil in small samples of oilseeds :*

By effecting slight modifications in the rapid method for the determination of oil in oilseeds (reported in 1950-51) the iodine value of oil in oilseeds can be determined with fair accuracy using about 0.5 gm. sample of the seed. This has been possible since it was established that the yield of oil is the same when the seeds are extracted with carbon tetrachloride as with benzene (see results in Table I) and that the iodine value of the expressed oil is the same as that of the carbon tetrachloride extracted oil (see results in Table II).

TABLE I

Comparative extraction of oil seeds with benzene and carbon tetrachloride

Name of seed	% yield with benzene	% yield with carbon tetra-chloride
1. Linseed	46.1	46.6
2. Saflower seed	28.9	28.7
3. <i>Biassica campestris</i>	43.2	43.4
4. Tobacco seed	40.7	41.4

TABLE II

Iodine values of expressed and carbon tetrachloride extracted oils

Name of seed	Iodine value of expressed oil, conven- tional method	Iodine value of carbon - tetrachloride extracted oil, present method.
1. Linseed ..	183·9	182·3
2. Saflower seed ..	136·7	136·6
3. <i>Brassica campestris</i> ..	103·8	100·6
4. Tobacco seed ..	131·5	131·2

2. Insecticides, fungicides & synergists :

(a) *A rapid routine method for the estimation of nicotine in plant tissues and insecticides :*

The method is applicable to nicotine concentrations as small as one part per million within 2 per cent error. The method will have special value for studying the biogenesis of nicotine in plant tissues.

(b) In the course of the preparation of intermediates for the production of organic thiocyanates as insecticides, it has been found that longifolene—a sesquiterpene of Indian oil of turpentine—can be chloracetylated with chloroacetic acid without the use of any condensing agents. This has resulted in obtaining a product of higher purity with better yields.

(c) A method for the simultaneous production of terpene ethers and alcohols has been developed using Indian oil of turpentine as raw material. The method has commercial possibilities for the production of synthetic pine oil, insecticides and synergists.

VI. SOIL MICROBIOLOGY

1. Utilisation of Singhbhum phosphate :

Phosphate obtained from Raka mines in Singhbhum district in Bihar showed a beneficial effect on mustard. It increased the yield of grain by 152 per cent and of the straw by 50 per cent over the control in Delhi soil. In the case of wheat an increase of 42 per cent over control both in grain and in straw were obtained.

2. Study of the *Azotobacter* species isolated from different Indian soils :

Organisms isolated from a number of soils having pH varying from 3.7 to 8.6 were studied for their cultural and biochemical characteristics. The soils used for study were collected from Poona, Coimbatore (Black soils), Nagpur (Black soil), Nagpur (Paddy area), Hooshangabad (Black soil), Delhi, Karjat, Thottapally, Porakad, Kanpur, Shahjahanpur, Hathaura, Ferozepur, Rohtak, Karnal, Banaras and Nilgiri.

3. Inoculation experiment :

Experiments show that inoculation of soil is decidedly effective in the case of gram against inoculation of seeds which, except in one case at Ludhiana, showed no benefit. This shows that the failures hitherto met may be due to defect in inoculation.

4. Influence of different methods of inoculation on gram in heavy and light soils under pot culture conditions at Delhi :

Almost in every case inoculation of soil gave the best results so far as the yield of gram seeds was concerned. With the local variety inoculated proved more efficacious in heavy soil than in light soil (NP 53) while reverse was the case with the Kabuli variety.

5. Mechanism of nitrogen fixation in *Rahar* :

In different fertiliser treatments the highest yields of *rahar* have been obtained with nitrogen which shows that so far as the crop of *rahar* is concerned the plant is not wholly dependent on nitrogen fixation through nodule organisms. Previous studies have shown that the *rahar* crop does not bear nodules after eight weeks' growth when unmanured and after 12 weeks' growth when manured with phosphate. Manuring of *rahar* with nitrogen alone appears to be essential. K has a distinct depressing effect. Water culture experiments were carried out only with nitrogen free solution but also in atmosphere made free of combined nitrogen. Results indicate that the *rahar* plant

possesses some sort of mechanism (probably through leaves) by which it fixes atmospheric nitrogen to some extent, in the complete absence of combined N.

6. *Manurial value of sannhemp seeds :*

Nitrification studies revealed that the nitrogen of the sannhemp seeds when applied to Delhi soil on equal nitrogen basis with that of mustard cake nitrified to a greater extent than that of the latter.

40 lb. of nitrogen applied under field conditions to wheat in the form of sannhemp seeds increased the yield of wheat by 84.4 per cent and of its straw by 95.7 per cent over the control.

In pot culture studies sannhemp seeds proved their superiority not only over the control but also over the mustard cake.

VII. BIOCHEMISTRY

1. *Chemical composition and nutritive value of wheat :*

(a) *Chemical composition of wheat :*

Wheat grown with different manurial treatments in the Permanent manurial and Rotational experiments at Pusa (Bihar) was analysed for its chemical composition. The application of N alone appears to have increased the protein content of the grain. The ash and phosphorus contents of the grain were also increased by the application of F.Y.M. and P, PK, NPK, NP. A few important varieties of Indian wheat were also analysed for their chemical composition.

(b) *Riboflavin content of different varieties of wheat :*

Twenty three important varieties of Indian wheat were analysed for their riboflavin content which was found to vary from 0.80 to 1.008 micrograms per gm. There appeared to be no correlation between the riboflavin and nitrogen contents of grains.

(c) *Riboflavin content of wheat as influenced by manurial treatments :*

Wheat (NP 52) grown with different manurial treatments in the permanent manurial and rotational experiments at Pusa (Bihar) was analysed for their riboflavin content. None of the treatments, such as F.Y.M., rape cake, NPK, green manure and legume rotation seem to have altered the riboflavin content of the grains.

(d) *Nicotinic acid content of different varieties of wheat :*

A simple and easy method for the estimation of 'Bound' and 'Total' nicotinic acid in wheat was standardised and the results were found to agree well with those obtained by other methods. Nine important varieties of Indian wheat were analysed for 'Bound' and 'Total' forms which lie between 17.3 to 27.5 micrograms per gm. and 33.4 to 46.2 micrograms per gm. respectively.

2. *Mechanism of nitrification in the soil :*

Methods were developed for correcting the loss of moisture when nitrification experiments are conducted in test tubes with 10 gm. of soil. The optimum requirement of moisture under these conditions of experiment was found to be 20—25 per cent in the case of Delhi soil. By this technique spoiled milk powder was found to nitrify at the same rate as compared to that of ammonium sulphate. The results obtained by this technique compared favourably with those obtained by the conventional method.

3. Amino-acid composition of food and feeding stuff :

(a) Paper chromatography :

Paper chromatographic technique for the identification and estimation of different amino acids has been standardised using the ascending method. R_f values of the amino acid, such as, phenylalanine, alanine, tryptophane, lysine, leucine, methionine and histidine have been found reproducible. This method has been made quantitative by extracting the coloured spots with acetone and measuring the colour intensity with Lumetron 402E. The curves showing relation between the optical density and concentration of amino-acids appear to be linear. Standard curves with different concentrations of amino acid have been prepared.

4. Studies on the chromatographic separation and estimation of carotene in plant materials :

Method for the estimation of carotene in plant materials has been standardised. 26 green leafy vegetables were analysed for carotene content. Green leaves, specially those of Jute, Neem, Mithaneem, Drumstick, etc., were found to be rich in carotene. The β -isomer was predominant in the green leaves. The mature leaves contained higher content of carotene. Six varieties of sweet potato were analysed for their carotene content which varied from 0 to 42.8 p.p.m.

5. Utilisation of mango seed kernel :

An economic method has been developed for the removal of tannin from mango seed kernel. The processed mango seed flour contained about 3 per cent tannin as compared to the original kernel which contained about 15 per cent tannin on dry basis. Starch prepared from mango seed kernel was analysed for their chemical composition and viscosity. In viscosity it compared favourably with corn starch.

6. Biochemical studies on tomato :

(a) Vitamin C content of different varieties :

26 varieties of tomato were analysed for their vitamin C content which varied from 28.2 to 72.4 mg. per 100 gm. The ripe fruits contained the highest amount of this vitamin.

(b) Carotene content of different varieties :

A method was developed for the estimation of carotene in materials rich in lycopene like tomato. 26 varieties of tomato were analysed for this constituent which was found to vary from 4.0 to 15.7 micrograms per gm. Carotene was also estimated at different stages of ripening and was found to be high in the ripe stage.

VIII. PHYSICS

1. Quantitative estimation of trace elements by the cathode layer arc :

Cathode layer arc technique, for the quantitative estimation of the trace elements as developed by earlier investigators was modified so as to increase both intensity of emission as well as uniformity of illumination in the spectral lines. This modification was necessitated by the observation that the emission from 3 mm. layer of a 10 mm. arc column starting from 1 mm. away from the cathode towards the anode gave lines of uniform and maximum intensity unlike those that were observed using other segments of the arc column. These results throw light on the best possible utilisation of the cathode layer arc effect in the quantitative estimation of trace elements.

2. Standardisation of spectrographic method for the estimation of carotene in leafy vegetables :

The absorption spectrographic method for the quantitative estimation of carotene has been standardised for concentration of carotene in petroleum ether varying between 0.4 to 2.2 p.p.m. This technique was used for the estimation of carotene separated from green leafy vegetables by using the chromatographic technique.

MISCELLANEOUS

Agriculture in Ancient India : (I.C.A.R. Scheme) :

In the prehistoric period before 3250 B.C. there is no evidence of the practice of agriculture in India, but probably it was about this time that human race passed from the life of the hunter to that of the nomad shepherd and thence to the tiller of the ground.

In the proto-historic age (3250-2750 B.C.) the art of agriculture was widely practiced and crops like wheat, barley, sesamum, field peas, brassica were grown. Cow, buffalo, sheep, elephant, pig, camel and fowl were domesticated. Irrigation on a small scale was followed.

Agriculture made its real headway in the early Vedic Age (Rig Vedic Age C.2500 B.C.). Agricultural operations were carried out exactly in the same way as they are at present done in remote villages. The plough share was made of iron, thus replacing the one made of *Khadira* wood, and ploughing was done by means of two oxen. Sickles were used for reaping. The value of manure was early appreciated and green manure also seems to have been used for the nutrition of plants. Irrigation was freely practiced. Cultivation suffered from the usual pests. Cattle were the most valued possession and the chief form of wealth of the Rig Vedic man.

C. ADVISORY

1. *Analysis :*

During the year under report a total of 384 samples were analysed and results issued to various Government Agencies and to some private institutions.

Soils	...	...	...	...	256
Manures & fertilisers	...	...	...	...	22
Water	...	...	...	...	10
Tomato	...	...	...	...	56
Oil Cakes	...	...	...	...	7
Miscellaneous	...	...	...	...	33
TOTAL					384

2. *Supply of bacterial cultures :*

139 tins of Bacterial culture for inoculation of legume seeds were supplied to interested persons with necessary instructions for using them.

3. *Advice to States :*

(a) Dr. S. P. Raychaudhuri acted as a member of Expert Committee set up by I.C.A.R. to scrutinise the Research work of the Agricultural Chemistry Section of the Madhya Pradesh Government.

(b) At the request of the Chief Commissioner, Himachal Pradesh, Dr. R. V. Tamhane submitted a report suggesting the methods for general improvement in agriculture in the State including a detailed programme of soil survey project.

(c) At the request of the Director of Agriculture, Rajasthan, Dr. R. V. Tamhane carried out a reconnaissance Soil Survey of the commanded area of Chambal-Hydel Project and submitted a report.

4. *Notes prepared :*

The following are some of the more important notes which were sent to Food & Agricultural Organisation of the United Nations, various Government Departments of

the Centre and the States and to other agencies on request.

Notes	To whom sent
1. Studies on the quality of wheat ...	Agricultural Research Workers Conference at Coimbatore, held under the auspices of I.C.A.R.
2. Role of clay in soil ...	The Secretary, Indian Council of Agricultural Research.
3. A report on mapping and classification of Indian soils.	Dr. J. Lossing Buck, Chief Land Use Branch, Agricultural Division, F.A.O., Rome.
4. Scientific manuring of crops in a rotation to build up soil fertility.	Meeting of Soil & Crops Wings of the Advisory Board of I.C.A.R. held at Indore, 1952.
5. Compost making ...	Deputy Commissioner, Delhi.
6. Manurial value and cost of production of compost, pitted manure and unpitted manure.	Extension Development Commissioner, Ministry of Food & Agriculture.
7. Cowdung gas plant ...	Animal Husbandry Commissioner, I.C.A.R.
8. A note on manure vaccine marketed by vaccine gessel schaft weltzen (Germany).	Ministry of Food & Agriculture.
9. Indigo manufacture ...	Donald Bros. Ltd., Dundee.
10. Work done on Animal Nutrition with relation to soil & chemical Factor in India.	Ministry of Food & Agriculture.
11. Comments on the effect of Krilium and sodium and potassium silicates on soil aggregation.	Ministry of Food & Agriculture.
12. Comments on the value of ammonium magnesium phosphate on Indian soils.	Ministry of Food & Agriculture.
13. Suggestions on manures & fertilisers ...	G.M.F. Enquiry Committee.
14. Notes on river valley projects ..	C. R. Fritz, Programme Assistant, Technical Co-operation Administration, American Embassy, New Delhi.
15. Information about Indian soils ...	Director of Agriculture, Bombay.

PROGRAMME OF WORK FOR 1952-53

I. SOIL CHEMISTRY :

(a) *Agricultural Chemistry* :

- (i) Utilisation of wild legumes for green manuring.
- (ii) Fertiliser value of di-calcium phosphate.
- (iii) Effect of free phosphoric acid and moisture on the physical condition of superphosphate and rotting of bags.
- (iv) Effect of pre-treatments of seeds in nutrient solution on crop growth.
- (v) Utilisation of some waste nitrogenous materials as manures.
- (vi) Studies on chemical composition of crop.

(b) *Soil Chemistry* :

- (i) Studies on saline & alkaline soils of Delhi State.
- (ii) Studies on the uses of 8-hydroxy-quinoline for the direct estimation of Fe, Al, Ca and Mg.

(iii) Mineralogical make up of Indian soils and its relation to base exchange reaction.

(iv) A study of the nature of laterite soils.

(c) *Soil Fertility* :

(i) Building up of soil fertility by the phosphatic fertilization of legumes :

(a) Lysimeter experiments,

(b) field experiments,

(c) pot experiments.

(ii) Study of new systems of crop rotation.

(iii) Compost experiments.

(iv) Production of fuel gas and manure from cowdung.

(d) *Micronutrient elements* :

(i) Mineral nutrition of gram (*cicer arietinum*).

(ii) Micro-nutrients in grasses, forages, etc.

(iii) Micro-nutrients status of Indian soils.

(iv) Work on citrus (Scheme of Research on Minor or Trace Elements, financed by I.C.A.R.).

II. SOIL PHYSICS :

(i) Moisture conservation in soil due to different cultivation treatments.

(ii) Aggregate formation in soil resulting from different cultural operations.

(iii) Technique of soil moisture by tensiometer.

III. PHYSICAL CHEMISTRY :

(i) Electro-chemical and mineralogical properties of hydrogen clays from typical Indian soils.

(ii) Electro-chemical properties of the mixtures of pure clay minerals.

(iii) Base exchange studies in clays and clay minerals.

(iv) Physico-chemical properties of humic acid isolated from *Kari* soil from Travancore.

IV. SOIL SURVEY :

(i) Effect of tractor cultivation on fertility status of Black soils at Bhopal.

(ii) Soil studies of Chambal Hydel project area.

(iii) Soil Survey & Collection of master profiles of Delhi Zone.

(iv) Laboratory and field experiments of Krilium as soil conditioner. (The investigations will be jointly carried out by the Soil Survey Section and Agricultural Chemistry Section).

(v) Mineralogical analysis of sand and clay fraction.

(vi) Cartography and preparation of maps of Delhi zone.

(vii) Soil Survey of Rann of Cutch.

(viii) Soil and land use survey of Delhi villages under intensive cultivation scheme.

V. ORGANIC CHEMISTRY :

1. *Oils, Fats & Oilseeds* :

(a) Detection of adulteration of (milk) ghee.

(b) Development of suitable methods for determining the quality of oil in small samples of oil-seeds (Scheme of the Indian Central Oilseeds Committee).

(c) Prevention of rancidity of oils & fats.

2. Pesticides :

- (a) Investigations on the biogenesis of nicotine (in collaboration with the Division of Botany). Development of semi-commercial method for the production of nicotine sulphate from tobacco waste.
- (b) Synthesis of organic thiocyanates, organic phosphorus and sulphur compounds; organic mercurials, halogen derivatives; ethers and alcohols derived from terpenes of Indian oil of turpentine.
- (c) Formulation of insecticides.

3. Animal Products :

Utilisation of bones as fertiliser, and other industrial purposes.

VI. SOIL MICROBIOLOGY :

- (i) Activation of *Azotobacter*.
- (ii) Effect of different phosphates on Guar as a green manure crop.
- (iii) Effect of different groups of organisms when added along with F.Y.M. in increasing soil fertility.
- (iv) Testing the effects of different methods of inoculations for different kinds of crops and soils.
- (v) Mechanism of N-fixation in Rahar.
- (vi) Study of wild leguminous plants in search for species which can fix large amount of atmospheric nitrogen.
- (vii) Study of the *azotobacter* species in Indian soils.

VII. BIOCHEMISTRY :

- (i) Chemical composition and nutritive value of different varieties of wheat as influenced by soil and climatic factors.
- (ii) Biochemistry of nitrification in the soil.
- (iii) Amino-acid composition and the biological value of protein in different food and feeding stuff.
- (iv) Nutritive value of different hybrids of tomato, sweet potatoes, etc.
- (v) Mechanism of biological synthesis of carotene in plants.
- (vi) Utilisation of mango-seed-kernel.

VIII. PHYSICS :

1. Quantitative estimation of Trace elements by cathod layer arc technique.
2. Quantitative estimation of carotene by the absorption spectrograph method.
3. Nicotine in tobacco.

REPORT OF THE DIVISION OF ENTOMOLOGY FOR THE YEAR 1951-52

(Dr. E. S. Narayanan)

SECTION OF PARASITOLOGY

(A) *Fundamental studies on insect parasitism :*

(i) *Bionomics and skeleto-muscular mechanism of Lestodryinus pyrillae Kieff* : During the year the bionomics of this important parasite were studied. *Lestodryinus pyrillae* is a very beneficial parasite on the nymphal stages of *Pyrilla* spp. in the sugarcane growing tracts of North India. A marked sexual dimorphism is noted in the parasite. In the female the last tarsal segment is modified into an enlarged claw and one of the regular claws is enormously developed into a chelate claw. This is an adaptation for holding the host. It has been found that the female parasite has a definite preference for the 2nd, 3rd

and 4th instar nymphs of the host for parasitisation. The host nymphs develop a saccular structure known as "thylacium", 5-13 days after parasitisation on the dorsum in between the wing pads. Though, as a rule, only one egg is oviposited on a single host, it was once observed that two fully developed grubs emerged out from a host. The sac bursts after 15 days and the fully developed parasite larva emerges out of the host. The bursting of the sac is followed by the death of the host nymph and herein lies the economic importance of the parasite. Sections of the host with the developing parasitic grub showed that the grub was feeding on the vital tissues and musculature in the thoracic region. The grub now pupates on the sugarcane leaf and after a pupal period of about 20 days the adult emerges out. The adult parasite lives up to 40-50 days.

A hyperparasite of this beneficial parasite has also found. The life-history of this parasite covers 13-15 days. However, the percentage of attack is very negligible.

(ii) *Studies on the host preference of Trichogramma evanescens minutum* R : Experiments were carried to find out the factors that govern the host-selection of *Trichogramma*. These investigations have revealed some very important factors that govern host selection. The experiment was conducted with the eggs of different alternate hosts, namely, *Sitotroga cerealella*, *Chilo zonellus*, *Gnorimoschema operculella*, *Corcyra cephalonica* and *Heliothis armigera*. It was found that strains of *Trichogramma* reared from *G. operculella*, and *C. cephalonica* preferred only *Gnorimoschema* eggs. These experiments have revealed that the size of the host eggs has got no significance in the matter of preference of the host. When two hosts are available simultaneously for oviposition, the distance between the adjacent host eggs has a considerable effect on the rate of egg deposition by the parasite. The shape of the host egg is also of no significance in the selection of the host. As revealed from the experiments the texture of the host eggs seems to be the dominant factor that governs the host selection of *Trichogramma*. It is also observed that as the host population increases, the efficiency of the parasite also increases. It is further observed that parasites reared from *Gnorimoschema* eggs are far more robust and healthier than the parasites bred on other alternate hosts.

(ii) *Effect of different temperatures and humidity on the longevity and fecundity of Trichogramma evanescens minutum* R : The parasites were bred at the optimum temperature and humidity (80°F and 75 per cent. humidity) and then were transferred to 68°F. and 45 per cent. R.H. and were allowed to breed. Similarly parasites bred at optimum temperature and humidity were allowed to breed at the same temperature but different humidities, viz., 45 per cent., 65 per cent., 75 per cent. and 85 per cent. In another set of experiments the parasites were bred at 68°F. and different humidities and then they were kept at the same temperature and relative humidity for further observations on longevity and fecundity. It was seen from the experiments that at low humidity (45 per cent.) the parasites behaved better and lived longer than they were bred at 80°F. and 75 per cent. relative humidity and then transferred to 68°F. and 45 per cent. relative humidity than those that were bred at 68°F. and 45 per cent. relative humidity. But in case of other humidities the results were reversed, i.e., the parasites under different conditions lived longer when they were bred at 68°F. and 65 per cent., 75 per cent. or 85 per cent. relative humidity and then kept at the same temperature and humidities than those parasites bred at 80°F. and 75 per cent. relative humidity and then transferred to 68°F. and different humidity series. The fecundity of the parasite was always better when it was bred at 68°F. and any of the relative humidities experimented upon in this series and then kept at the same temperature and humidities, than those that were bred at 80°F. and 75 per cent. relative humidity and then transferred to 68°F. and different corresponding relative humidities. The statistical analysis has given a highly significant value to these results.

(iv) *Studies on Indian Ichneumonidae : Sub-family Ophioninae* : C. Morley (1913) divided this sub-family into Paniscides, Anomalides, Campoplegides, Cremastides, Pori-zonides, Ophionides, Nototrachides, Pristomerides and Mesochorides. After critical

examination of this sub-family it was decided to reclassify this sub-family into Ophionini, Anomalini, Cremastini and Porizonini tribes containing 40 genera and 168 species. This is a contribution to our knowledge of this important group. Metopiides and Mesochorides tribes of Morley were raised to the rank of sub-families in accordance with the recent trends in the taxonomic work of this family. They have now been critically examined. Sub-family *Ichneumonique* (= *Phaeogenini*) was left off by Morley in the Fauna of British India; Hymenoptera 3, (1913). This sub-family has now been classified for the first time in our country into 5 tribes, namely, Alomyini (= *Phaeogenini*), Pristiceratini (= *Platylabini*), Amblytelini, Ichneumonini, and Joppini including in all 46 genera and 100 species. Final catalogue and reclassification of the sub-family Pimplinae comprising 8 tribes, 29 genera and 127 species have been prepared. This reclassification is a valuable contribution to our knowledge of this important group. The sub-family *Cryptinae* of previous authors has been changed into *Gelinae*. With a view to prepare a Fauna of India of the sub-family *Gelinae* for the first time in this country, the collection of original description of 5 genera and 45 species has also been completed.

(B) *Biological control of insect pests (mass breeding of parasites) :*

1. *Trichogramma evanescens minutum* R : A fairly large culture of this important parasite was maintained in the laboratory throughout the year. About 9 million parasites were bred during the year. About 20,000 parasitised *Corcyra* eggs were sent to the Entomologist, Gurdaspur, for controlling the borer eggs and about 7,000 were supplied to the Entomologist, Madhya Pradesh, Nagpur, for releasing against *Heliothis* eggs. The parasites were also released in fields under Delhi Intensive Cultivation Scheme in Nangloi village for controlling the borers.

2. *Bracon gelechiae* Ashmead : The parasite was bred exclusively on the laboratory host, *Corcyra cephalonica* St. at the rate of about 1,500 parasites per month.

3. *Stenobracon deesae* Cam : The breeding of the parasite on *Corcyra* host on the basis of the new technique evolved in this Division, was continued during the year.

(C) *Studies in insect physiology :*

(i) *Studies on Rhizopertha dominica* Fabr. (Bostrichidae : Coleoptera, a pest of stored cereals and milled products) : Life history studies showed that during July and August the period of incubation was 4-5 days. The development from egg to adult was completed in 30-50 days with wheat flour as food. There was heavy mortality at all stages of development. Comparative damage caused to barley, jowar, wheat and crushed wheat was also studied. Crushed wheat suffered most followed by jowar, wheat and barley. To study the susceptibility of some common varieties of wheat, oats and barley to its attack, a known number of grains of different varieties of wheat (NP 4, NP 111, NP 165, NP 80-5) and oats (NP I, NP II, Hyb. × — 27) Hyb. 1 and Hyb. 3) were kept in a bottle with a known number of insects. Also marked grains of all these varieties and barley (NP 13) were kept mixed together and with a known number of insects. It was observed that the oats and barley suffered very little damage as compared to the wheat. Amongst the wheat varieties NP 165 suffered comparatively more damage than the other varieties. Further experiments were laid out with a view to find out whether there was any effect of the broken grains or of the flour of these varieties on the increase of population of this insect.

(ii) *Studies on Sphaerophoria scutellaris* Fabr. (Syrphidae : Diptera) : During studies on this predator it was observed that males were more active than females, but comparatively smaller in size and short lived. During the winter with an average temperature of 61.1°F. and relative humidity of 56.3 per cent., the average longevity of male was 9.5 days, that of females 13.3 days, the pre-oviposition period 5.5 days, the pre-copulation period 3.1 days, the copulation period 35 minutes, the interval between copulation and

first oviposition 56 hours, the oviposition period 6.3 days, the number of eggs laid per female 29, the post-oviposition period 36 hours, the incubation period 2.8 days, the average larval period 10 days and full period of life cycle was 20-25 days.

The maggots feed on aphids. Their mode of feeding was also studied. In the absence of aphids they are cannibalistic. The adults feed on nectar and pollen and also serve as pollinators.

The flies were fed on : (a) distilled water, (b) 5 per cent. honey solution, (c) 5 per cent. cane sugar solution and some were kept unfed. These were placed at 18°C., 25°C. and 30°C. with relative humidity of 70 per cent. The experiment was replicated four times. The longevity of flies was significantly increased when fed with 5 per cent. sugar solution or 5 per cent honey solution as compared to distilled water, and the sugar solution was superior to honey solution in this respect.

(D) Apiculture :

The possibility of keeping honey bees (*Apis indica*) in Delhi was given a trial at I.A.R.I., New Delhi. It was found that bees could fairly flourish even when the maximum temperature touched 122.2°F. in summer, and the minimum temperature went down for a short duration almost near the freezing point in winter. At no time of the year is there dearth of nectar secreting plants, but they are in abundance only from the beginning of March and end of May, which is the main season of honey flow. This season is therefore, necessarily short. The brood rearing activity is almost nil from November till the end of January. It then gradually increases and during March to May, the activity is at its zenith. It slows down in June due to hot and dry weather. However, the activity of the colony begins to increase from about the middle of July upto October when the colony regains somewhat its origin strength. Then the decline begins and the activity ceases from November owing to the shortage of nectar and pollen.

The bees collected nectar mainly from the flowers of the following plants :—

- Mangifera indica* L. (Anacardiaceae)
- Citrus reticulata* Blanco. (Rutaceae)
- Citrus aurantiifolia* Swingle (Rutaceae)
- Campsis grandiflora* K. Schum (Bignoniaceae)
- Melia indica* Brandis (Meliaceae)
- Syzygium fruticosum* DC. (Myrtaceae)
- Syzygium cumini* (L.) Skeels. (Myrtaceae)
- Sesamum orientale* L. (Pedaliaceae)
- Medicago sativa* Linn. (Leguminosae)
- Trifolium alexandrinum* L. (Leguminosae)
- Bauhinia variegata* L. (Leguminosae)
- Helianthus cucumerifolius* Torr. and Gray (Compositae)
- Terminalia arjuna* Bedd. (Combretaceae)

They collected pollen mainly from the flowers of the following plants :—

- Cucumis melo* L. var. *utilissima* (Cucurbitaceae)
- Grewia asiatica* L. (Tiliaceae)
- Zinnia elegans* Jacq. (Compositae)
- Zea mays* L. (Gramineae)
- Crotalaria juncea* L. (Leguminosae)
- Tropaeolum majus* L. (Tropaeolaceae)
- Lagerstroemia indica* L. (Lythraceae)
- Cucurbita maxima* Duch. (Cucurbitaceae)
- Helianthus annuus* L. (Compositae)
- Solanum melongena* L. (Solanaceae)
- Imperata cylindrica* Beauv. (Gramineae)
- Tribulus terrestris* L. (Zygophyllaceae)
- Digera arvensis* Forsk. (Amaranthaceae)

Pennisetum typhoides Stapf & Hubbard (Gramineae)
Sorghum vulgare Pers. (Gramineae)

They collected both nectar and pollen from the following plants :—
 Swartz (Verbenaceae)

Musa sapientum L. (Musaceae)
Brassica campestris L. var *sarson* Prain. (Crucifereae)
Murraya paniculata Jack (Rutaceae)
Pongamia pinnata Merr. (Leguminosaeae)
Chrysanthemum sp. (Compositae)

SECTION OF SYSTEMATIC ENTOMOLOGY

(i) *Bruchidae* (= *Lariidae*) : In continuation of previous work on this line male and female genital characters of one more species of the genus *Bruchus* viz., *B. albopubens* Pic. collected from Guar pods (*Cyamopsis tetragonoloba*) have been studied in detail.

(ii) *Synonymy of Anobiidae and Ptinidae* : A detailed study of the morphological structures of male and female genitalia of the available specimens in the National Pusa Collection have been made and it is tentatively concluded that the male genital structure of *Ptinidae* as a whole is simpler when compared to that of *Anobiidae*.

(iii) A new accessory organ to aid oviposition and boring in *Scelio oviphagus* spp. parasitizing the eggs of *Hieroglyphus nigrorepletus* Bol., has been described. (*Current Science*, June 20, 1951). A detailed morphology of the new species has also been worked out and the result is under publication.

(iv) A technique for determining accurately the areas of contact of body to the ground surface of insects in locomotion has been evolved and a paper in this connection has been sent for publication.

(v) Detailed biological and morphological studies of *Eusarcocoris ventralis* (Pentatomidae) were made and certain features of genitalia of male and female adults have been found which are of particular interest in that these features do not appear to have been recorded previously.

(vi) Morphological and biological studies of *Pyrilla* spp. (Fulgoridae), a serious pest of sugarcane in India indicate that there is only one species of the genus in India, viz., *P. perpusilla* Wlk. and that *P. pusana* Dist., is only a coloured form of the former species. This finding is therefore contradictory to the earlier statement of Qadri (1950). A new coloured variety of *P. purpusilla* not yet recorded has also been collected from the vicinity of Delhi.

(vii) Studies on the permeability of insect chitin to aqueous stains and their relationship to vulnerability indicate that as against normal abraided areas in insect chitin natural unabridged areas (apparently without lipoid layer) also exist. These areas are not only variously distributed in different regions of the same insect but also vary considerably in their location in insects of different orders. Preliminary experiments on the insecticidal action in aqueous media on these permeable regions have given encouraging results.

SECTION OF ECOLOGY AND TOXICOLOGY

1. Epidemiology of spotted bollworm of cotton :

This is a long range project which has been in progress since 1940. The collection of bioclimatic data was continued. Also the data collected since 1942 were under analysis by Statistician's staff and this Division has been discussing and studying the various approaches from the Entomological angle. Obviously there is a strong correlation between population fluctuation and the seasonal complex. Hence different types of transformations have to be tried.

2. Ecological studies on *Trichogramma* sp. for constructing Biometer :

Rearing of *Trichogramma* sp. under different controlled temperatures (12°C., 18°C., 25°C., 30°C. and 35°C.) was carried out. The data collected are given in Table I.

TABLE I

Results of rearing *Trichogramma* sp. at different temperatures and humidity

Temperature	12°C		18°C		25°C		30°C		35°C	
Humidity	35%	75%	35%	75%	35%	75%	35%	75%	35%	75%
Blackening period in days	16-18	16-18	6-7	6-7	3-5	3-5	3-5	3-5	3-5	3-5
%Parasitisation ..	14	20	30	51	28	42	29	42	28.5	36
Emergence period in days	..	..	16-17	16-17	8-10	8-12	7-9	7-9	..	7-9
%Emergence ..	..	..	39	43	29	33	30.5	33	..	28
Longevity in days ..	..	..	1-5	1-6	1-3	0-6	0-2	0-2	..	0-1
Total life period in days	..	..	17-22	17-23	9-13	8-18	7-11	7-11	..	7-10

3. Ecological studies on *Heiroglyphus nigrorepletus* :

Following three tentative conclusions have been arrived at from the data collected so far :

- Grasshoppers are generally polyphagous. All the same this insect shows specificity for food plants ; it dies of starvation if offered only *guar* or cotton leaves.
- Daily watering of pots containing eggs is harmful for hatching.
- Lower relative humidity (30 per cent.) is adverse for the nymphs as they cannot complete their nymphal development under this humidity.

4. The loss of water from insect bodies under different physical environments :

These studies were carried out with four species of test insects, viz., *Oxycaenus laetus*, *Euproctis lunata*, 7th and 8th stages of *Periplaneta americana*, and adults of *Coccinella septumpunctata* kept without food under four different relative humidities, viz., 25 per cent., 50 per cent., 90 per cent. and 100 per cent. It was observed that :—

- In all the four species of insects studied, the loss of weight during any particular period was higher at the lower humidities than at higher humidities. Presumably this loss in weight represents primarily the loss of water from the insect's body.
- Like loss in weight the percentage mortality during any particular period was inversely proportional to the relative humidity.

5. Effect of temperature on insects' resistance to insecticides :

The effect of post-treatment temperature on insects' resistance to DDT dust was studied. Adults of *Tribolium castaneum* Hb. pre-treated at 17°C., were dusted with 0.5 per cent. DDT in 3 sets which were kept at 17°C., 25°C., and 30°C. for post-treatment reaction. The relative humidity was maintained at 45 per cent. in dessicators. The results obtained showed that there was a higher mortality at lower post-contact temperatures, i.e., the post-treatment temperature coefficient was negative.

6. Effect of temperature on insects' susceptibility to fumigation :

Studies on the effect of temperatures existing during the different stages of fumigation operation were carried out involving investigations on (i) the effect of pre-fumigation temperature under 6 combinations of fumigation and post-fumigation temperatures, (ii) the effect of fumigation temperature under 16 combinations of pre-fumigation and post-fumigation temperatures and (iii) the effect of post-fumigation temperature under 22 combinations of pre-fumigation and fumigation temperatures. These observations are briefly summarised in Table II.

TABLE II

Analysis of effects of different temperature components on the mortality of *T. castaneum* adults fumigated with carbon disulphide and ethylene dichloride

Temperature component	Effect	Temperature combinations (in °C)		
		Prefumigation temperature	Fumigation temperature	Post-fumigation temperature
Prefumigation temperature		16, 25 & 33	25	16 33
	+effect	*16, 28 & 35	28	16 35
		16, 25 & 33	25	25
	Not clear	*16, 28 & 35	28	28
Fumigation temperature ..	+effect	25	16, 25 & 33	16
		28	18, 28 & 35	
		18	18, 25 & 20	18
		30		
		13	13, 22 & 29	22
		25	18, 25 & 30	25
		30		
		*28	16, 28 & 35	28
		18		
	±effect	25	18, 25 & 30	30
		18		
		13	13, 22 & 29	18
	+effect for some days and ±effect for rest of days.	13	13, 22 & 29	25
		*28	16, 28 & 35	29
				13
	±effect	16	25	16, 25 & 33
		18	28	16, 28 & 35*
			25	18, 25 & 30
			30	
			18	18, 25 & 30
		25	25	16, 25 & 33
			25	
		*28	33	16, 28 & 35
		33	28	16, 25 & 33
		*35	25	16, 28 & 35
			28	
		13	13	13, 22 & 29
		18	22	
		25	18	18, 25 & 30
			16	16, 28 & 35
		*28	28	
			35	
			18	
		30	25	18, 25 & 30
Post fumigation temperature	+effect	30	30	18, 25 & 30
	-effect	13	29	13, 22 & 29

+effect, i.e., increase in kill with rise in temperature.

-effect, i.e., increase in kill with fall in temperature.

±effect, i.e., decrease in kill with rise in the temperature to a certain degree but increase in kill with further rise.

*These experiments were carried out with ethylene dichloride and the rest with carbon disulphide.

7. Bioassay of insecticides :

(i) *Insecticidal tests on eggs of phadka (Heiroglyphus nigrореpletus)*. Egg-pods of this grass-hopper species were buried in soil in pots and watering was done on alternate days. After 9 days the pots were dusted with DDT, BHC and toxaphene. Subsequently watering was continued as before. It was observed that very few nymphs emerged in the dusted pots and even those that emerged died after a few days although all normal care was taken of them.

(ii) *Comparative toxicity of modern insecticides to Psocids* : Aldrene, BHC, Lethane, Chlordane and DDT were tried as 0.5 per cent. emulsions against Psocids. Results showed that Aldrene was most toxic followed by BHC which showed almost the same toxicity as DDT.

(iii) *Insecticidal test on 'ak' grass-hopper* : Tests with five insecticidal preparations were carried out to study their comparative toxicity to this species. The order of toxicity of the insecticides tried was found to be : BHC spray > BHC dust > Toxaphene dust > DDT dust = DDT spray.

(iv) *Insecticidal tests of samples received from the Chemistry Division* : Nine samples received from the Chemistry Division were tested for their toxicity to different insect pests and their toxicity compared with allied members of the modern insecticides.

8. I.C.A.R. Scheme on DDT and allied insecticides :

(A) *Trials of DDT and BHC against termites in wheat and sugarcane fields* : Field experiments (planned on randomised block design) were carried out to study the effect of the treatment of soil with 3 dosages of DDT and 4 dosages of BHC on (i) termite incidence, (ii) plant growth and (iii) absorption and translocation of these insecticides in wheat plants. As there was practically no termite attack even in the controls, the differences were statistically insignificant. The experiments were carried out in collaboration with the Division of Chemistry and Agronomy.

(B) *Studies on the comparative toxicity of the modern insecticides against Indian insect pests* : (a) 2.5 per cent., 2 per cent., 1 per cent. and 0.5 per cent. suspensions of wettable powder of Toxaphene were prepared and sprayed on *Euproctis* larvae as the test insect. Rather unexpectedly the observations showed that mortality of these larvae was more (100 per cent. in 3 days) when they were sprayed with 1 per cent. and 0.5 per cent. suspensions and less (70 per cent. to 80 per cent. in 3 days) with higher strengths of 2 per cent. and 2.5 per cent.

(b) Laboratory trials with emulsions of DDT, BHC, Aldrin, Parathion, Dieldrin and Chlordane with *Tribolium castaneum* adults as the test insect gave the following tentative order of toxicity, viz., parathion > aldrin > dieldrin > BHC > DDT = Chlordane.

(c) Preliminary trials with Pestox 3H against mustard aphids on mustard and radish plants : Irrigation with Pestox solution (1 in 800 parts of water) at the recommended rate of 1 oz. per 12.5 sq. inch of surface area of potted plants showed that :—

(i) Translocation of this poison was quicker in mustard plants than in radish.

(ii) The order of susceptibility of different forms of aphids to the action of this poison was found to be : nymphs > apterous forms > alate forms.

- (iii) About 50 per cent. of the apterous forms were capable of reproduction after the knock down effect and about 25-30 per cent. of the progeny could survive to maturity if untreated plants were available ; otherwise the whole progeny perished.

Small mustard plots in the field were also irrigated with Pestox solution at the above rate. The average population of aphids in the treated plots per plant was 475 against 1689 in the control about one month after the treatment. The coccinellid beetles that predate on the aphids were not affected.

(C) *Persistence and phytotoxicity of modern insecticides* : Spraying of two concentrations of emulsions of DDT, BHC and Aldrin on castor, cotton, maize, berseem and lucerne showed that out of these three insecticides, DDT was the best both as regards persistence and phytotoxicity. The effect of 1 per cent. and 2 per cent. emulsions of DDT on castor leaves persisted for about 50 days despite a shower of 0.1" of rain received, 17 days after application. The effects of 0.5 per cent. emulsions of aldrin and BHC were lost in 15 days. No phytotoxicity was observed with any of the above insecticides in the case of castor, cotton and lucerne. About 7 per cent. and 10 per cent. of the berseem leaves were burnt by 2 per cent. DDT and 0.5 per cent. aldrin respectively ; 0.25 and 0.5 per cent. BHC damaged about 7 per cent. and 25 per cent. of the berseem leaves respectively. Also about 4-5 per cent. and 5-7 per cent. of the maize leaves were damaged by 1 per cent. and 2 per cent. DDT respectively. No damage to the plant as a whole was noticed either in berseem or in maize.

(D) *Effect of modern insecticides on the viability of stored grains and their freedom from pests* : Preliminary observations on the treatment of Moong seeds (i.e., 682) by 10 per cent. DDT dust showed that the germination of these seeds 4 months after treatment was as satisfactory as in the control. During this period of storage, Bruchid infestation increased from 5 per cent. to 24 per cent. in the treated seeds and from 5 per cent. to about 45 per cent. in the control. In another set of experiments, 10 varieties of cowpeas and one variety each of wheat and gram were treated with dusts of DDT, Toxaphene and BHC, and stored under normal conditions of storage.

PROGRAMME OF RESEARCH WORK OF THE ENTOMOLOGY DIVISION FOR THE YEAR 1952-53

I. INSECT PARASITOLOGY

A) *Fundamental studies on insect parasitism* :

- (i) Host selection studies on *Bracon gelechia* Ashmead and *Trichogramma evanescens minutum* R. and *Stenobracon deesae* Cam.
- (ii) Bionomics and morphology of *Lestodryinus pyrrillae* Kieff. (Dryinidae : Hymenoptera).
- (iii) Effect of laboratory hosts on the sex-ratio of *Stenobracon deesae* Cam.
- (iv) Attempts to breed *Bracon gelechia* Ashmd. which will be immune to DDT.
- (v) Revision of Morley's Ichneumonidae.

B) *Studies on stored grain pests and their natural enemies.*

(C) *Studies on Insect Physiology :*

- (i) Factors responsible for the production of winged aphids.
- (ii) Studies on *Rhizopertha dominica* Fabr. :—Susceptibility of some common varieties of wheat, oats, etc.
- (iii) Studies on *Sphaerophoria scutellaris* Fabr. :—Longevity and fecundity at controlled temperature and humidity with different artificial food.
- (iv) Studies on the gland secreting pupation hormone in *Didacus ciliatus* (Leow.).

(D) *Apiculture.*(E) *Biological control of insects :*

- (i) Culture of parasites will be continued.
- (ii) Control of Maize and Jowar borers by releasing the egg-parasite, *Trichogramma evanescens minutum*.

II. INSECT TAXONOMY

- (a) Cataloguing of Indian Insects : (i) Tachinidae and Asilidae (Diptera) and (ii) Eumenidae (Hymenoptera) in the series of Catalogue of Indian insects.
- (b) Studies on the genitalia of Anobiidae and Ptinidae (Coleoptera) to be continued as and when more specimens become available.
- (c) A comparative study of the male genitalia of Eumenidae available in the National Pusa Collection.
- (d) Studies on the genitalia of Thysanoptera from the systematic point of view.
- (e) Morphology of certain structures of insect pests with special reference to their vulnerability to insecticides in aqueous media.

III. INSECT ECOLOGY AND TOXICOLOGY

- (a) Epidemiology of cotton bollworms.
- (b) Ecological and Toxicological studies on *Hieroglyphus nigrorepletus*.
- (c) Loss of water from insects' body—water balance in insects.
- (d) Studies for constructing biometers.
- (e) Bioassay of insecticides.
- (f) Effect of temperature on insects' susceptibility to insecticides.
- (g) Studies on the phytotoxicity and persistence of insecticides under field conditions.
- (h) Effect of chemical treatment on viability of seeds of different grains.
- (i) I.C.A.R. Scheme on DDT and allied insecticides.

IV. MISCELLANEOUS AND ROUTINE OBSERVATIONS

(1) *Observations on Indian insects of economic importance---*

- (a) Pests of crops at I.A.R.I. and in the neighbouring villages with a view to assist local cultivators in controlling the pests (including rodents) under the Delhi Intensive Cultivation Scheme.

- (b) Fruit pests.
 - (c) Pests of potato.
 - (d) Pests of sugarcane and their natural enemies.
 - (e) Predators and parasites in general.
- (2) Studies of immature stages to fill up certain lacunae.

REPORT OF THE DIVISION OF MYCOLOGY AND PLANT PATHOLOGY FOR THE YEAR 1951-52

(Dr. R. S. Vasudeva)

A. SECTION OF PLANT PATHOLOGY

Wheat :

(a) *Rust* (*Puccinia graminis tritici* (Pers.) Erikss. & Henn., *P. triticina* Eriksson, *P. glumarum* (Schmidt) Erikss. & Henn.) : Studies on the physiologic races of black, brown and yellow rusts of wheat were continued. Analysis of 104 collections of rusts of wheat from different localities in India showed that races 21 and 42 of black rust, 20 and 63 of the brown and 19 and A of yellow rust were most common and widely distributed throughout the country. Other races met with in order of prevalence were 40, 24 and 34 of black rust ; 108, 106 and 107 of brown rust ; and races D and E of the yellow rust. Race 107 of brown rust was confined in its distribution only to Southern Peninsular India (Madras and Travancore).

A search for the collateral and alternate hosts of the wheat rust fungi was continued. It was found that in Ootacamund (Nilgiris) the wild grasses, *Vulpia myurus* and *Briza minor*, were infected with Races 4 and 6 of *Puccinia graminis avenae*. At I.A.R.I., New Delhi two grasses, *Bromus catharticus* and *B. japonicus*, and a wild barley (*Hordeum murinum*) were infected in nature with race 19 of yellow rust. During the summer of 1952, 104 collections of rusts on wild grasses were made at various altitudes in Southern Bombay, Mysore, Madras and North Travancore and are being studied with a view to determine if any of these are identical with the physiologic races of the rusts of wheat. Thirtyone species of imported grasses were tested in the seedling stage against mixtures of races of black, brown and yellow rusts of wheat and black rust of oats, of which 9 proved susceptible or semi-resistant to *Puccinia graminis tritici* ; 3 to *P. triticina* ; 12 to *P. glumarum* and 14 to *P. graminis avenae*. In all, 3472 grass seedlings were tested in this connection.

Rust resistance tests were carried out with 31,149 plants of various wheat varieties, their crosses and progenies. Of these 8,676 plants were tested in the seedling stage and 22,473 in adult stage. In addition, observations regarding rust incidence were made on 15,940 plants of different wheat varieties naturally infected in the field at the Wheat Breeding Station, Simla.

In the Seedling Resistance tests Exotic varieties E.572, E.581, E.871, W.206-Plant 9, and W.206-Plant 40 were found resistant when tested against the 9 Indian Physiologic Races of black rust except race 42. To a mixture of the nine races of black rust Pb. C45-56-Plant 1 ; W.375-S.81 (Delhi) ; W.375-S.128 (Simla) ; W.392-S.51 (Simla) ; *Agropyron deseriorum* (E.C.1974) and inbred Rye (E.C.1171) were found resistant ; as also 11 selections from the crosses made with Gabo and N.P.165, N.P.710, N.P.761 and Niphad 4.

As regards Seedling Resistance to individual races of the brown rust, Exotic Varieties E.928, E.931, E.938 and E.957 were found resistant. To a mixture of the 8 races of brown rust Exotic varieties E.15, E.304, E.305, E.337, E.352, E.386, E.898, E.930, E.952 and Af.31-1 (*Triticum persicum*) reacted as resistant; as also the Assam Rye, Australian Rye, Russian Rye, the Rye tetraploid, wheat varieties Ujjain, S.40 and 6 selections from the crosses made with Gabo and N.P.710, N.P.165 and Niphad 4.

Exotic variety E.740 was found resistant to all the 10 Indian races of yellow rust individually. A number of varieties and selections from Crosses were found resistant to the mixture of all the 10 races of yellow rust, chief among them being I.C.834 (*Triticum dicoccum*), E.952 (*T. vulgare*), *Agropyron caestiposum*, *A. seabrum* (E.C.1800), *A. paniciforme* (E.C.1798), *Aegilops ventricosa*, Pb.C.244, 228, 45-56-Plant 1, W.375-S.128 (Simla), W.392-S.51 (Simla), W.375-S.81 (Delhi), Pb.C.591 × E.220-Plant 3, Gabo × Niphad 4-Plant 40, and W.10 × N.P.710-Plant 8 and 9.

No variety was found resistant to a mixture of all the 27 races of black, brown and yellow rusts of wheat found in India.

In the Adult Resistance tests, 29 exotic and 9 Indian wheat varieties, 58 cultures of hybrids and 17 cultures of allied genera were found resistant to a mixture of 9 Indian races of black rust. To a mixture of all the 8 races of brown rust 43 exotic varieties, 14 Indian varieties, 4 cultures of Fixed Hybrids, 10 cultures of allied genera, 41 cultures of Delhi Hybrid selections and 6 cultures of new crosses and selections in F_1 proved resistant. To a mixture of the 10 races of yellow rust 24 exotic varieties, 6 Indian varieties, 3 Fixed Hybrids, 7 other cultures and 8 cultures of allied genera reacted as resistant.

(b) *Smut (Ustilago tritici* (Pers.) Rostrup.): Studies on the resistance of wheat varieties to loose smut were continued in co-operation with the Division of Botany. Final observations of 175 varieties raised from seed obtained from ears inoculated in the previous season (1950-51) with isolate L₁ and a mixture of L₁ and L₂ isolates of *U. tritici* showed that in the case of isolate L₁, 66 varieties remained free from infection; 24 showed less than 10 per cent infection; 18 had 30-50 per cent; 26 gave 50-80 per cent and in the remaining 18 the infection varied from 80-100 per cent. Varieties Pb. 8A, Pb.C.518 and Pb.C.591 which were used as controls developed 50, 72.7 and 67.2 per cent infection respectively. With the mixed inoculum of L₁ and L₂ isolates, 22 varieties showed 80-100 per cent infection, 27 gave 50-80 per cent infection in 12 the infection ranged from 10-30 per cent and 18 developed less than 10 per cent infection; whereas 75 remained free from smut. Sixtyone varieties that have remained free from infection by all the three isolates may be regarded as promising from the point of view of resistance.

During the present season 54 wheat varieties have been inoculated with L₁ and L₂ and L₃ isolates for the varietal resistance test. Furthermore, experiments were also in progress to determine the optimum conditions of successful inoculation of the loose smut, e.g., different methods of inoculations at different times of the day, incubating the inoculated plants at different temperatures and humidity.

Physiologic Races: In connection with the studies on the physiologic races of the wheat loose smut fungus, 16 varieties representing 5 species of *Triticum* were inoculated with 26 loose smut collections from different wheat varieties and localities in the country and then tested for loose smut development. Ten collections have shown some indications of Physiologic specificity particularly on wheat varieties E.14 (*Triticum sphaerococcum*), N.P.710, 711 and 759. It was found that N.P.710 was susceptible to isolate

L₁ but immune or resistant to other 9 isolates; variety E.14 was immune to isolates L₂, K and C, resistant to L₇ and A10, susceptible to L₁₁, L₃, L₆ and L₉ isolates; whereas N.P.711 reacted as resistant to isolate L₃ and immune to L₅. N.P. 759 proved resistant to L₁ and L₆ and immune to L₃ and L₁₃. These results, however, require to be confirmed.

During the current year 13 wheat differentials used by Dr. Hanna of Dominion Rust Research Laboratory, Canada, for the determination of physiologic races of loose smut of wheat, were inoculated with 21 collections of *Ustilago tritici* obtained from different parts of the country and different wheat varieties.

(c) *Foot-rot (Fusarium sp.)*: The occurrence in a severe form of foot rot disease in the neighbourhood of Delhi was reported last year. A species of *Fusarium* was isolated from foot rot affected seedlings collected from Nangloi in December 1950. This fungus proved to be pathogenic in pot cultures and was used for further studies to see the effect of soil temperature, soil texture and farm yard manure on the severity of the disease. At an average soil temperature of 19-26°C., 62.5 per cent plants of wheat (N.P.771) were effected with foot rot; at 13-23°C. 54 per cent of the plants were affected, while there was no infection at 15°C. In another pot experiment at an average soil temperature of 25.6°C. 52 per cent plants of wheat variety N.P.771 were effected in unsterilised soil from a foot rot affected plot in the presence of additional inoculum of the *Fusarium*. In pots filled with 1/6 sand mixed with soil the infection was 28 per cent but when 1/6 manure was added 44 per cent. infection was recorded. These experiments indicate that foot rot is more severe in sandy or manured soils, and at high soil temperature.

Field observations on the incidence of the disease in a 'date of sowing experiment' laid out in the Agronomy Division with 3 varieties of wheat N.P.771, N.P.710 and N.P.165 sown on 20-10-51 (when the maximum temperature was 99.1°F.) showed that the incidence of foot rot was 80, 70 and 60 per cent respectively, whereas seedlings of the same varieties sown on 15-11-51 and 8-12-51 (average maximum temperature of 87.1°F. and 75.1°F. respectively), remained free from foot rot infection.

(d) "*Tundu*" Disease (*Corynebacterium tritici* (Hutchinson) Bergey et al.): Investigations on "*Tundu*" disease (*Corynebacterium tritici*) were continued. It was seen that the disease is associated with "Ear cockle" due to the nematode, *Anguillulina tritici*, which carried the bacterium mechanically into the plant. Repeated inoculations with a pure culture of the bacterium by different methods under optimum conditions for infection failed to produce the disease; but when nematode galls were used, as soil infection at the time of sowing, 40 to 60 per cent infection was easily obtained. It was also observed that soil-moisture content and time of sowing had considerable effect on the incidence of the disease. No infection was obtained when the soil-moisture content was upto 25 per cent, but it increased progressively with increase in soil-moisture. The disease appeared in a more severe form in October-sowings than in November-sowings, and this was further aggravated by liberal irrigation of the plots, while the December-sown crop remained free from infection. Solar heat treatment (maximum ground temperature 135°F.) was not found effective in controlling the disease, but removal of galls by floatation almost completely checked the disease. This simple method proved to be quite efficacious even with large samples (20-25 seers) of seed and, therefore, can be safely recommended to the cultivators.

(e) *Bacterial Black Chaff of Wheat (Xanthomonas translucens var. undulosum)*: In the wheat plots of the Botany Division 26 exotic varieties, received from U.S.A. for breeding rust resistant varieties, showed symptoms of bacterial Black Chaff or Pseudo Black Chaff. The former is caused by *Xanthomonas translucens var. undulosum* which is hitherto unrecorded from India, and the latter is a physiological disorder. A yellow

bacterium which resembles *X. translucens* var. *undulosum* in all its major characters was isolated from 10 varieties with Hope and H₁ parentage. Further work is in progress to prove the pathogenicity of the isolate. It appears that the disease, if present, has been introduced into the country along with the imported seed, as the pathogen is seed-borne.

Barley :

(a) Rust (*Puccinia graminis tritici* (Pers.) Erikss. & Henn. and *P. glumarum* (Schmidt) Erikss. & Henn.) : The collections of rust-affected barleys obtained from different localities in India, and analysed for the determination of physiologic races yielded races 21 and 34 of the black rust and races 19 and G of the yellow rust.

Rust resistance tests with 25 varieties of barley were carried out with 339 plants in the seedling stage and with 390 plants in the adult stage. In the seedling stage no variety was found to be resistant, but in the adult stage 6 varieties proved resistant to all the 9 races of the black rust in mixture ; one variety reacted as resistant to a mixture of the 10 races of the yellow rust and 14 varieties were found resistant to a mixture of all the 19 Indian races of the black and yellow rusts of barley. In addition observations were also recorded on about 3,000 barley plants at the Wheat Breeding Station, Simla, regarding the incidence and intensity of rust infection on different barley varieties.

(b) Loose Smut (*Ustilago nuda* (Jens.) Rostr.) : An experiment was carried out to further confirm the efficacy of the solar treatment for the control of loose smut of barley. Heavily infected barley seed was soaked in cold water for 2, 3 and 4 hours and then exposed to sun on a brick floor on the 21st June, 1951 when the maximum ground temperature of 59°C. was reached at 1.00 P.M. The treated seed was sown along with the untreated controls in November, 1951. No case of smut appeared in the plots sown with the solar treated seed. It might, however, be mentioned that the smut incidence in the untreated control seed was also low.

Sugarcane :

Studies on the diseases of sugarcane with particular reference to red rot and smut were continued. The cultural variability and differences in pathogenicity of 32 isolates of *Colletotrichum falcatum* on 10 selected sugarcane varieties, were also studied. In co-operation with the Director, Sugarcane Breeding Institute, Coimbatore, studies were made on the inheritance of resistance to red rot and smut of sugarcane varieties and *Saccharum* spp. with a view to evolve disease resistant varieties. Nearly 20,000 canes and 9,500 setts were inoculated in various tests at Delhi, Karnal and Coimbatore.

(a) Red Rot (*Colletotrichum falcatum* Went) : For the selection of resistant cane varieties for general cultivation and for breeding work 99 parent cane varieties including *Saccharum spontaneum* and other *Saccharum* spp. and 10 standard cane varieties to serve as controls were tested by the plug method with *C. falcatum* isolate No. 244. Twenty varieties were found resistant, 56 moderately resistant and 23 susceptible. These varieties were also tested for the nodal infection which is the chief source of red rot infection in nature. Eleven varieties showed less than 15 per cent infection, 9 showed 15-25 per cent infection, 31 showed 25-30 per cent infection and the remaining 48 varieties had 50-100 per cent infection.

Physiologic races : Thirty two isolates of *C. falcatum* obtained from different varieties and localities in India were tested for their virulence on 10 selected varieties of different genetic composition. Little physiological specificity was, however, observed in any of the isolates. The recent isolates obtained from Co.313 and Co.453 from Bihar, Co.453 from U.P. and Co.312, Co.313 and Co.421 from East Punjab were highly virulent though they were not as virulent as the isolate 244 which was used for the general tests. Co.356 and Co.421 showed appreciably greater infection than in the past few years.

Varietal resistance tests at Coimbatore : Twenty six varieties of Co.349 (highly resistant) parentage, 34 varieties of the Co.301 (resistant) parentage and 23 varieties of Co.281 (moderately resistant) parentage were tested for Red Rot resistance by plug method. In addition 114 parent cane varieties, 84 P and 89 G series of final test seedlings, 97 new Coimbatore series (Co.836 to Co.932), 30 important commercial varieties of India and 112 *Spontaneum* collections, were also tested for Red Rot with isolate 244 of *C. falcatum*. The results are awaited from Coimbatore.

Preliminary investigations : Comparative tests for the resistance to red rot of 20 sugarcane varieties by inoculating the cut canes and the standing canes showed that 19 varieties showed high infection by the first method and only 8 varieties by the second method. The efficacy of application of sulphur at the time of planting for increased resistance to red rot was tested with 10 varieties. Five varieties showed no difference in the treated and untreated plots; 2 showed more infection in the sulphur treatment while 3 varieties showed less infection as compared to the control. Hot water treatment of setts at 52°C. for 20 minutes was found to be ineffective for the control of red rot.

(b) *Smut (Ustilago scitaminea Syd.)* : Varietal resistance tests were carried out at Deeni and Karnal by dipping 50, 3-budded setts of each variety for half an hour in smut spore suspension and then planting them in the field for smut infection observations. Out of the 89 varieties under test at Karnal, 9 showed less than 5 per cent infection, 11 showed 5—15 per cent, 17 showed 15—30 per cent, 16 showed 30—50 per cent and the remaining 36 varieties showed 50—100 per cent infection. Of the 99 varieties tested at Delhi, 19 showed less than 5 per cent infection, 12 showed 5—15 per cent, 19 showed 15—30 per cent, another lot of 19 showed 30—50 per cent infection and in the remaining 30 varieties the infection ranged from 50—100 per cent.

Gram :

(a) *Seed rotting (Pythium ultimum Trow)* : Studies were continued on the taxonomy and pathology of a *Pythium* sp. obtained from diseased gram plants. The fungus resembled most closely with *Pythium ultimum* Trow. Measurements of 100 sporangia, oospores and oogonia were taken and the average worked out to be 21.2 μ 18.7 μ and 22.6 μ respectively. Comparative measurements of *Pythium ultimum* of a week old culture as given by Middleton are 20.0 μ for the sporangia, and 16.5 μ and 20.6 μ respectively, for the oospores and oogonia. These measurements are slightly smaller than the gram *Pythium*. This appears to be the first record of a seed rotting *Pythium* on gram in India. Pathogenicity tests were carried out in sterilized and natural soils, with the gram *Pythium* and an authentic culture of *Pythium ultimum*. In sterilized soil the gram fungus showed 86.9 per cent rotting as against 93 per cent caused by *Pythium ultimum* while in the natural soil the percentage of seed rotting was 34.7 and 48.4 respectively. In sterilised soil the *Pythium* isolated from gram also produced 27.2 per cent wilting, while the authentic culture of *Pythium ultimum* did not cause any wilt in any of the soil infection experiments. The effect of 0.2 per cent Ceresan on seed rotting of gram (Type N.P. 28) by *Pythium ultimum* (Indian isolate) was tested in sterilised and natural soils.

A preliminary experiment was carried out to test the survival of the *Pythium* sp. in soil. Pots containing soil in which 100 per cent seed rotting was obtained were exposed to the summer heat during 1951 and gram seeds were sown in November in these pots without the addition of fresh inoculum. These pots showed 58.5 per cent seed rotting and 8 per cent wilting, showing thereby that the gram seed-rot fungus can survive in the soil through the summer heat of Northern India plains.

(b) *Wilt (Fusarium orthoceras App. et Wr.)* : In four gram plots of the Mycology Division severe wilting (15.5 per cent) was observed towards the end of March, 1952. In view of the fact that late sowing is considered an effective measure of controlling

gram wilt, it was unusual for wilt to appear so severely in the crop sown as late as early December. Microscopic examination revealed typical *Fusarium* wilt symptoms. Two hundred and eighty isolations were made from 48 wilted plants and a *Fusarium* sp. was found to be predominant in these isolations. In addition *Rhizoctonia bataticola* was obtained in 8 cases. These isolates will be tested for their pathogenicity.

Linseed :

Rust [*Melampsora lini* (Pers.) Lev.] : One hundred and eight hybrid strains of linseed and their parents received from the Division of Botany were tested in the seedling and adult stages against a mixture of the 4 Indian physiologic races of *Melampsora lini*. Over 4,000 plants were inoculated and it was found that 98 varieties were immune or resistant both in the seedling and the adult stages. Six cultures were semi-resistant in the seedling stage but resistant or immune in the adult stage. Two cultures were susceptible and 2 gave mixed reactions.

Studies on the inheritance of races 3 and 4 of the linseed rust showed that race 4 formed telia 10 days earlier than race 3 under Delhi conditions, especially on Williston Golden, Akmolinsk, J.W.S. and Argentine selections. Successful germination of teliospores was obtained after soaking them in water for 7–10 days at 12–18°C. Seedlings inoculated with teliospores of races 3 and 4 separately produced pycnia in 7–9 days. The uredial culture of 'selfed' races 3 and 4 resemble the parent races in their pathogenicity on the differential hosts and therefore these races appear to be homozygous. Further tests in the F_2 generation will be carried out to confirm these results.

Pigeon-pea :

Wilt (*Fusarium udum* Butler) : Wilt resistance of 20 selected pigeon-pea varieties was tested both in pots and in wilt-sick plot. Varieties N.P. 41, C.15 W.E., C.38-3-1 and N.P. 69×P.48-A and P.1 did not show any infection, while D.16-17-2 W.E. and D.419-2-4 had 3.3 per cent and N.P.69×P.131-3 and P.2 6.6 per cent infection. These varieties and cultures may be regarded as resistant. Other varieties showed more than 20 per cent infection in the infection tests carried out in the pots. In the field the maximum infection of 11 per cent was obtained in N.P.69 whereas varieties N.P.41, C.38-3-1, D.419-2-4 and N.P.69×P.48-A and P.1 remained free from infection.

Bajra :

Green Ear (*Sclerospora graminicola* (Sacc. Schroet) : During the Kharif season 1951 shredded bajra leaves containing mature oospores of *Sclerospora graminicola* were collected for experimental purposes from the bajra fields at Nangloi and the Agronomy Division. The oospores were stored at room temperature, freezing temperature, 5°C., 35°C. and 40°C. and also in the soil under natural conditions for weathering. Germination tests of the material stored at room temperature were carried out. The material collected from I.A.R.I. area in 1948, 1949 and 1950 and Nangloi material collected in 1951 showed very poor germination. Local material collected in 1951 was used for soil infection in pots where only 4 out of 1,855 seedlings showed sporangial infection. Germination tests with oospores stored under different conditions are in progress. Attempts are also being made to determine the conditions which would increase the germination of the oospores and the infection of the bajra plants. Field experiments have been laid out to study the incidence of the disease in various varieties of bajra and to study the natural transmission of the disease to other crops like *Setaria italica*, *Euchlaena mexicana* and maize.

Antibiosis : Studies on the inhibitory action of *Bacillus subtilis* on *Fusarium udum* and other pathogenic fungi were continued. The inhibitory action of *B. subtilis* was not specific to *Fusarium udum* but the growth of other fungi like *Rhizoctonia bataticola*, *R. solani*, *Alternaria solani*, *Collectotrichum falcatum* and to a small extent even of *Botrytis cinerea* was inhibited in potato dextrose agar medium in the presence of the

bacterium. A filtrate of the bacterium failed to check the growth of *Fusarium udum* in soil, but slight inhibition of the growth of the fungus was, however, observed. The filtrate with varying pH lost its activity when passed through bed of soil. After passage through the soil shift in pH was observed but even when the pH was restored to the original, the filtrate still remained inactive.

The filtrate was found to be toxic to the growth of *Alternaria solani* in the potato dextrose medium. Experiments carried out *in vitro* on detached potato leaves showed that no *Alternaria* spots are formed if the filtrate is applied simultaneously or 8 hours after inoculation of the leaves with the pathogen. If the filtrate was applied one or two days after inoculation with *A. solani*, the disease incidence was 20 and 40 per cent respectively. There was complete control of the disease if the filtrate was applied 4, 8 and 12 hours before inoculation. On living plants also the disease was kept in check if the filtrate was applied simultaneously with the inoculum, but if it was applied after 1, 2 or 4 days of inoculation, the disease incidence was 5, 30 and 80 per cent respectively. In one of the experiments potato plants were raised in sand cultures and fed with the filtrate. The plants were afterwards sprayed with *A. solani* spores. The disease was observed in the inoculated plants which had been fed with the filtrate, showing thereby that the inhibitory principle is probably lost in the host tissues or partly in sand and partly in the host. Germination studies of *Alternaria solani* spores in the presence of the filtrate showed that spores treated for 48 hours in the filtrate failed to germinate even after 72 hours. When the spores were soaked in the filtrate for 15 hours, their germination was scanty and the germ tubes were deformed. Potato leaf juice at different dilutions inactivated the filtrate.

Fungicides: Replicated field experiments were conducted to test the relative efficacy of five common fungicides on the emergence, stand and yield of Maize (Yellow N.P. 2), Wheat (N.P. 715) and barley (N.P. 13). The germination, stand and yield of plots sown with seed treated with different fungicides and the untreated controls were as follows :—

	Agrosan	Ceresan	Spergon	Copper Carbo-nate	Luna-san	Control
Maize—						
Germination (%)	50.7	57.5	66.9	58.2	55.7	50.5
Av. Height per plant (inches)	41.3	36.1	41.8	39.7	41.8	40.0
*Yield	..	..	..	..	..	..
	Agrosan	Ceresan	Spergon	Aagrano	Lunasan	Control
Wheat—						
Germination (%)	62.5	66.4	65.9	64.7	64.6	58.4
No. of plants (per running foot)	7.4	7.9	7.8	7.7	7.7	6.9
Av. Height per plant (inches)	..	..	..	..	..	..
**Yield (Grain) (Lbs.)	45.6	58.75	46.0	49.25	49.75	44.1
(Bhusa) (Lbs.)	450.4	555.2	457.0	507.7	490.2	446.9
Barley—						
Germination (%)	86.5	80.1	83.5	77.3	83.1	73.4
No. of Tillers (per running foot)	24.1	20.7	22.1	20.5	21.7	18.5
Av. Height per plant (inches)	21.7	18.5	20.5	17.5	18.6	17.2
**Yield (Grain) (Lbs.)	20.25	22.25	19.5	19.0	19.0	22.5
(Bhusa) (Lbs.)	53.75	66.75	51.5	58.0	52.0	48.5

* Severe damage by birds.

** Severe hail storm damage.

In the final stages of these experiments reliable results could not be obtained because of the severe damage by birds to the maize crop and the hail storm damage to the wheat and barley crops. However, under the limitations of these experiments it was generally indicated that the fungicidal seed dressing improved the emergence, stand and yield.

Assessment of Damage : Field experiments were continued in order to assess the losses caused by black rust of wheat, rust of linseed, smut of sugarcane and leaf-curl of tomato. In the case of the black rust of wheat the weight of 1,000 grains from plants showing less than 5 per cent infection was taken as normal. The reduction in yield in plants showing 10—25, 40—50 and 50—60 per cent rust infections was 1.8, 8.5 and 21.1 per cent respectively in variety C.518.

The loss in yield due to linseed rust at different intensities of infection was determined for varieties N.P. 12 and N.P. 21. Six small plots, each measuring 15 ft. × 19 ft., were sown contiguously with these varieties. In the second week of February one plot of each variety was artificially inoculated with the uredospores of *Melampsora lini* and the rust infection was allowed to spread in the adjacent plots. The inoculated plots showed heavy infection, the next one showed moderate infection and the one farthest showed only light infection. From each plot all the plants were harvested separately and the loss in yield due to different intensities of rust was calculated on the basis of average yield per 100 plants and average weight of 1,000 grains. The loss in yield on 100 plant basis was greater than that calculated on the 1,000 grain weight basis. This is due to the fact that many rusted plants are killed outright without producing any seed in susceptible varieties like N.P. 21 and N.P. 12. With moderate and heavy rust infection in N.P. 12 the losses in yield on 100 plant basis were 25.7 and 61.4 per cent and on 1,000 grain weight basis 8.5 and 9.5 per cent respectively. The corresponding figures for variety N.P. 21 were 35.7 and 96 per cent; and 2.5 and 39.3 per cent respectively.

In the case of sugarcane smut it was observed that the smut infection caused 40 and 54 per cent reduction in yield in Co.313 and Co.312 respectively when the setts were infected at the time of planting. If the crop was planted with setts from smutted canes much greater reduction in yield was observed, viz., 69 per cent in Co.312 and 82 per cent in Co.313.

Tomato plants affected with leaf-curl produced on an average 12 fruits per plant as against 19 fruits produced by the healthy plant. The average yield per healthy plant was 34.3 oz. as compared to 21.1 oz. in a leaf-curl affected plant, thus indicating a loss of 38.5 per cent in yield.

Miscellaneous :

(a) *Soft-rot of vegetables and fruits :* Studies on the bacterial brown-rot of potatoes were continued. It was shown that the bacterial rotting of potatoes in Uttar Pradesh, Bihar, Madras and Bombay is caused by *Pseudomonas solanacearum* and is, therefore, the brown-rot of potatoes and not ring-rot which is caused by *Corynebacterium sepe-donicum*. It appears that two strains of *P. solanacearum* exist in India.

The taxonomy and pathogenicity of the bacterium causing leaf-spot of pomegranate hitherto unreported were studied. Cultural and biochemical reactions indicate that it belongs to the genus *Xanthomonas*.

Bacterial blight of cow-peas was observed in the Agronomy Division. The organism isolated from these plants resembled *Xanthomonas vignicola* in its host range and morphological and physiological characters.

(b) *Air-borne fungal spores* : In order to forecast the outbreak of cereal rusts and other fungal diseases, the aerobiological studies were continued. Glass slides thinly smeared with vaseline were exposed in aeroscopes to catch spores near the ground level. During the period December to April the slides were exposed twice a week and for the rest of the year only once a week. The uredospores of the yellow and brown rusts of wheat were first trapped during 24th—31st December 1951 and 7th—14th December 1951 respectively and the appearance of these rusts on the local wheat crop was observed on 22nd January 1952. The black rust uredospores were first trapped in the first week of February and the rust appeared on the 23rd February, 1952. As observed in previous years the *Alternaria* spores were trapped throughout the year. The spores of various moulds were common in August and the *Helminthosporium* spores from December to May. From November to April thick-walled uredo and teliospores of rust and smut spores were frequently observed.

(c) *Chilli wilt* : Severe wilting of chilli plants was observed in the Agronomy Division during September, 1951. Two hundred isolations of *Fusarium* were made from these plants and were grouped into 7 classes on the basis of cultural characters. *Fusaria* belonging to group 5 were the most virulent followed by groups 4, 2 and 1. The growth and cultural characters of the fungus were studied on different media.

(d) *Microflora of stored seed grains* : The ecto- and endophytic microflora of 12 varieties of jowar seeds, 10 varieties of paddy, 8 varieties of pea and 5 varieties of gram were studied. Spores of *Alternaria*, *Fusarium*, *Helminthosporium* and smut spores were observed in seed washings of paddy; pea seeds yielded *Fusarium* and *Alternaria* spores, uredospores of rusts and oospores of some *Phycomycetes*; while the seed washings from gram gave *Alternaria* and *Fusarium* spore only. When isolations from these seeds were made on 4 media (2 per cent Malt extract agar, potato dextrose agar at pH 4.5 and 7.5 and Smith Humfeld agar) a species of *Rhizopus* was found to be common on Jowar seed, a *Fusarium* sp. on rice, another *Fusarium* sp. on pea seeds and an *Alternaria* sp. on gram seeds. The role of these fungi on the emergence and stand of seedlings was studied.

As regards the endophytic flora obtained from the seeds after surface sterilisation a *Rhizopus* sp. was obtained predominantly from Jowar seeds. The rice samples showed 2—11 per cent *Fusarium* sp., 2 per cent *Alternaria* sp. and 2 per cent *Helminthosporium* sp. The pea seeds yielded *Fusarium* sp. 4—13 per cent, *Alternaria* sp. 4 per cent, *Aspergillus* sp. 4 per cent and *Penicillium* sp. 4 per cent, whereas the gram seed gave *Alternaria* sp. 6—11 per cent, *Mycogone* sp. 6—11 per cent and *Rhizopus* sp. 6 per cent.

The beneficial effect of fungicidal seed dressing treatment on germination and the growth of the seedlings was tested with Agrosan GN, Aagrano, Lunasan, Ceresan, Spergon, Granosan, Semesan, Uspulun—Universal, Hortesan A and Mersolite P. Dosage response tests were also carried out with Agrosan GN. The results obtained show that much of the pre-emergence injury is checked which results in better germination and the vigour of the seedlings is also improved. A concentration of 3 : 1000 of Agrosan GN has been found to be quite effective.

B. SECTION OF PLANT VIRUSES

Bottlegourd [Lagenaria Siceraria standl.] :

Mosaic (Cucumis virus 2C) : Experiments to study the effect of onion juice on the virus showed that the juice had no adverse effect on the infectivity of the virus. The virus in the expressed sap exposed for 6 days to volatile vapours of onions also remained unaffected. The virus when inoculated into *Datura* leaves was found to remain confined to the inoculated spot. Attempts to make the virus move in *Datura* plant by injecting the virus into petiole and stem remained unsuccessful. No infection was

observed through root absorption in the young *Datura* plants kept in a nutrient solution containing the virus. As regards resistance to alcohol, the virus can withstand 75 per cent absolute alcohol for 48 hours and 82 per cent for 24 hours. Experiments to study the insect transmission of the virus with Red Pumpkin beetle (*Aulacophora* sp.) and whiteflies (*Bemisia tabaci*) have given successful infection with the former.

Sannhemp (Crotalaria juncea Linn.) :

(a) *Mosaic* : Sannhemp mosaic virus obtained from the field in 1950 was under study. The virus was found to have a Thermal-death-point of 95—98°C. the Dilution-end-point between 1 : 500,000 and 1 : 100,000, and the longevity *in vitro* of 257 days at 6—10°C. Studies on the host range of the virus showed that on *Crotalaria mucronata* and *Phaseolus vulgaris* the virus produces typical mosaic symptoms; in the case of tobacco (*Herrison's special* and *White Burley*) the virus is carried symptomlessly in the inoculated plants during the colder months but at high temperature it shows symptoms of infection, producing faint mosaic mottling; on *Datura stramonium*, *Nicotiana glutinosa* and *Vigna sinensis* the virus produces local lesions, while *Lycopersicon esculentum*, *Solanum nigrum* and *S. nodiflorum* proved to be symptomless carriers. No infection was obtained on *Dolichos lablab* or any of the several cucurbitaceous hosts tested. Local lesions produced by the virus on *N. glutinosa* and *D. stramonium* varied with the dilution of the infective juice used for inoculation. The virus is found to resemble the sannhemp mosaic virus described from Poona rather than the one described from Delhi in 1947.

(b) *Phyllody* : The insect transmission tests to reproduce the disease by feeding viruliferous white flies affected with tobacco leaf-curl virus on the mosaic affected sannhemp plants remained unsuccessful. The disease was, however, successfully transmitted by grafting a phyllody affected shoot on healthy sannhemp plant.

Hibiscus rosa-sinensis L. :

Leaf-curl : The disease was successfully transmitted to *Abelmoschus moschatus* by grafting. Insect transmission tests with *Bemisia tabaci* gave indications of success in the case of *H. rosa-sinensis* but not with *Abelmoschus esculentus* or tobacco.

Tomato (Lycopersicon esculentum Mill.) :

(a) *Leaf-curl* : The losses due to leaf-curl disease in the field were assessed. The incidence of the disease in the experimental plots was 32.25 per cent. The average yield per Leaf-curl affected plant was 21.1 oz. as against 34.3 oz. of the healthy plant, and the average number of fruits per plant produced by the diseased and healthy plants was 12 and 19 respectively. Experiments were also in progress to find suitable control measures of the disease.

(b) *Necrosis* : The disease was found to be widespread in the I.A.R.I. area this year. The disease was successfully transmitted by grafting but not by sap inoculation. The disease was also transmitted to *Datura* by grafting. The diseased shoots of *Datura* when grafted back on healthy tomato plants produced typical necrosis on the new axillary shoots.

Nicotiana glauca :

Mosaic : Host range and physical properties of the virus were being further studied. The virus is sap transmissible and has a very wide host range. It has been successfully transmitted by sap inoculation to *Datura stramonium*, *Lycopersicon esculentum*, *Solanum nodiflorum*, *S. melongena*, *Cucumis sativus* and *Trichosanthes anguina*. These are in addition to the six hosts reported last year. The virus, however, could not be transmitted to *Luffa aegyptica*, *Citrulus vulgaris*, *C. vulgaris* var. *fistulosus* or *Langenaria siceraria*. Potato varieties Up-to-date, President, Arran Victory and

seedling No. 41,956 failed to take infection by sap inoculation, but the disease was successfully transmitted to *Up-to-date* plants by grafting. The virus has a thermal death point of 57-60°C., the dilution-end-point between 1 : 100 and 1 : 200 and longevity *in vitro* of 7-8 days at 6-10°C. On the basis of host range, symptomatology on different hosts and physical properties the virus closely resembles *Cucumis virus* 1.

Maintenance of nucleus disease-free Seed Potatoes :

Disease-free tubers of *Darjeeling Red Round* and various differential varieties of potato were raised in glass house and tested for freedom from virus infection and stored suitably. Some of the apparently healthy *phulwa* plants when tested on differentials revealed the presence of a virus which produced typical mosaic symptoms on *Nicotiana glutinosa* and necrosis on *Capsicum annum*. The virus is transmissible to tobacco varieties *Harrison's Special* and *White Burley* producing transient mottling. *Lycopersicon esculentum* and *Datura stramonium* were found to be symptomless carriers. The virus also infects *Solanum nigrum*. *S. nodiflorum* and potato varieties *Arran Victory*, *Craig's Defiance*, *President* and *Majestic*. The Thermal-death-point of the virus lies between 55-60°C. and the virus remains viable in expressed sap for 15 days at 6-10°C.

General :

Work on lupin, petunia, radish and groundnut mosaic, phyllody of *toria* and candy tuft, leaf-curl of papaya and chillies and malformation mango was also in progress. Lupin mosaic virus has been found to be sap transmissible and successfully infected sesamum, board beans and peas. The virus has a thermal death point of 55-60°C., Dilution-end-point between 1 : 100 and 1 : 200 and longevity *in vitro* of 10-14 days at 6-10°C. Phyllody of *toria* and candy tuft has been transmitted by grafting. Petunia mosaic has been found to consist of two types. Both are sap transmissible but one produces milder type of mottling than the other. They also differ in their host range and symptomatology on different hosts. Papaya leaf-curl, a serious and common disease in Delhi, was found to be transmitted by *Bemisia tabaci*. Radish mosaic proved to be sap transmissible and could also infect turnip, *toria* and *sarson*. The groundnut mosaic was successfully transmitted to groundnut and Bhindi by grafting. The study of phyllody disease of sesamum has also been just started under a special scheme of I.C.O.C.

C. SYSTEMATIC MYCOLOGY

Taxonomy : Studies on the genera *Collectotrichum*, *Cicinobolus*, *Cercospora* and *Tretopileus* were continued as also on the miscellaneous Indian fungi, consisting of individual specimens belonging to various genera, which were either a new record for India or a new species, e.g., *phyllosticta grewiae* on *Grewia asiatica*; *Sphaerella smilacicola* on *Smilax aspera*; *Marsonia* sp. on *Xanthoxylum alatum*, *Sclerotium rolfsii* on *Helianthus tuberosus*; *Alternaria dianthi* on *Saponaria vaccaria*; *Septoria* sp. on *Zinnia elegans*, *Adhatoda vasica* and *Launea asplenifolia*; *Glomerella* sp. on *Mangifera indica*; and *Helminthosporium* on *Lolium perrene*.

Glume Blotch of wheat, caused by *Septoria nodorum*, found to be doing extensive damage in the Nilgiris, has been described and the cultural studies of the fungus have given some indications as to the perfect stage of *S. nodorum*, which is hitherto unknown.

Critical studies of *Cicinobolus cesati*, a hyperparasite of powdery mildews, have revealed that *C. major* Kell and Swingle, *C. sigacollus* Rolden, *C. Major* Dearness & Bartholomew, *C. ulicis* Adams, *C. humuli* Fautrey and *C. quericinis* Syd. should be considered as synonyms of *C. cesati* de Bary.

Studies on the morphology and pathogenicity of *Peronospora* spp. were in progress and indications as to the existence of physiologic forms of *P. brassicae* have been obtained.

A monographic study of the powdery mildews of India has been started and was being pursued with the help of a Research Fellow of the I.C.A.R.

The work on the fungus flora of Delhi was also continued with a view to bring out a list of Fungi occurring in and around Delhi. In addition, about 280 mycological specimens collected locally during the weekly rounds were examined to study the distribution of the various fungi on different crops and other plants at the I.A.R.I. and their incidence throughout the year.

Indian Type Culture Collection : Fifty-six cultures were added to the collection during the year, thus bringing the total number of cultures in stock to 862. One hundred and thirty-nine cultures were supplied to scientific workers in India and abroad and various Institutions during the year. Information available from literature regarding various cultures in stock is being compiled and entered on special Forms maintained for the purpose. Studies on the preservation of fungi in mineral oil and sand are in progress. Cultures of *Phytophthora infestans* were successfully maintained on maltose-peptone-carrot-extract agar. Some of the Phycomycetous fungi have been found to remain viable for about 12 months at 12–16°C.

Herbarium Cryptogamae Indiae Orientalis : One hundred and thirty-four specimens were added to the herbarium raising the total number of specimens to 20,015. Most of these new additions are either new species or new host records for India. Two Exiccati Sets, each consisting of 50 specimens of Indian Uredinales, have been prepared and are ready for issue. 109 specimens were supplied to various scientific workers in India and abroad.

PROGRAMME OF WORK FOR 1952-53

I. Plant Pathological Investigations :

(a) Studies on cereal smuts.

- (b) Determination of physiologic races of *Ustilago tritici*, *Melampsora lini*, *Puccinia graminis tritici*, *Puccinia triticina*, *Puccinia glumarum* and *Colletotrichum falcatum*.

(c) Studies on rusts of wheat, barley, linseed and wild grasses.

(d) Green Ear disease of bajra.

(e) Wilt diseases of pigeon-pea and other crops of economic importance.

(f) Foot rot and bacterial diseases of wheat.

(g) Study of the microflora of seeds of food crops and the efficacy of different fungicides.

(h) Assessment of damage due to major crop diseases. Aerobiological studies.

(i) Testing varieties of crop plants evolved by the Botany Division for their resistance to diseases.

(j) Diseases of Sugarcane :—Varietal resistance for red rot and smut. Studies on the variation in *C. falcatum* and recurrence of the red rot epidemic.

(k) Studies on microbial antagonism.

(l) Bacterial brown rot of potatoes (*Pseudomonas solanacearum*) and Leaf spot of Pomegranate.

II. Plant Virus Investigations :

(a) The following viruses will be studied :

Bottlegourd mosaic virus, yellow vein mosaic of pumpkin, mosaic of *Carica papaya*, *Dolichos enation* mosaic, mosaic of sannhemp and phyllody, mosaic of brinjal, yellow mosaic of *Cajanus cajan*, leaf curl and necrosis in tomato, bhindi mosaic, mango malformation and banana mosaic virus, strains of sugarcane mosaic virus.

(b) Virus-vector relationships of the following viruses will be studied :

Mosaic of *Carica papaya*, pumpkin, bottlegourd and brinjal mosaic, sterility disease of *Cajanus cajan*, mango malformation and sugarcane mosaic.

(c) Isolation and purification of brinjal mosaic virus.

(d) "Katte" disease of cardamom and its control in Bombay.

(e) Survey of virus diseases.

III. Mycological Investigations :

(a) Study of the fungal flora of Delhi. Taxonomic study of new collections and unidentified collections available in the Herbarium Crypt. Ind. Orient.

(b) Maintenance of Indian Type Culture Collection of micro-organisms and their history sheets and study of methods for preservation.

(c) Additions to and maintenance of the Herbarium.

(d) Identifications of fungi and disease specimens.

IV. Miscellaneous :

(a) Maintenance of Host Index of Fungi ; preparation of card indices of species of fungi represented in India will be continued.

(b) Routine and Advisory, Post-graduate Teaching and Training and assistance and advice to Indian Council of Agricultural Research, Indian Central Sugarcane Committee and Indian Central Oilseeds Committee and Intensive Cultivation Scheme, Delhi State, in Mycological and Plant Pathological matters. Also co-ordination of mycological and plant pathological research.

REPORT OF THE DIVISION OF AGRICULTURAL ENGINEERING FOR THE YEAR 1951-52

(MR. R. V. RAMIAH)

General

(1) The buildings for the office and the workshops of the Division were not built even during this year. The office and workshops continued to be in a part of the area belonging to the Division of Agronomy as in previous years. Due to the lack of proper accommodation and very limited funds, restrictions had to be imposed on the research activities. The main activities of the Division were primarily the servicing, maintaining and repairing of machinery of other Divisions as well as the maintenance and operation of farm and dairy machinery of the Division of Agronomy. A major part of the work of this Division was that connected with machinery and tractors of the Agronomy Division.

(2) To study the progress made in the field of Agricultural Machinery and Tractors in foreign countries, catalogues, and trade literature of such machinery were obtained from several firms from the U.K., Switzerland and Japan. Action will be initiated to obtain a few of those, that may be applicable to our conditions.

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(3) The possibilities of manufacturing tractor tyres and tubes for replacements were examined at the instance of the Ministry of Food & Agriculture. A list of interchangeable tyres and tubes for tractors was sent to the Development Wing in the Ministry of Commerce and Industry for further action.

(4) At the instance of the Secretary, Ministry of Food & Agriculture, a conference of Agricultural Engineers, Implement Makers and Tractor Importers, is being organised. This conference is to be called as "Agricultural Implements and Machinery Conference" and will have regional branches. The agenda for the conference has been circulated to the State Governments and others through the Indian Council of Agricultural Research. The functions of the conference are to introduce and popularise improved agricultural implements in India and increase the production of quality implements by the Indian firms.

(5) (a) The Head of the Division, visited Central Rice Research Institute, Cuttack during the year to inspect and examine, if it was possible to produce a few Japanese agricultural machines on the models of those now available at the Central Rice Research Institute. One of these machines, a pedal operated thresher has been taken for production by Messrs. American Spring & Pressing Works, Bombay. Drawings and blue prints of some of the other machines such as power thresher, rice polisher, rice huller are being prepared. The Ministry of Food & Agriculture are also taking steps to get these machines manufactured for supplying to State Governments.

(b) The Indian Central Jute Committee, at Calcutta asked the Head of the Division to assist them in selecting the best jute seed drill for which a prize has been announced. As none of the jute seed drills at the contest came upto expectations, a hand operated jute seed drill, modified from a Japanese machine which had been received at the Indian Agricultural Research Institute, was sent to the Jute Agricultural Research Institute. It is now learnt, that the Jute Research Institute at Calcutta have built about one hundred of these machines in steel for distribution to the farmers.

(6) The following machinery and implements were received for trial and testing in the Division during the year :—

- (i) Peter Diesel Engine AVI, 5 B.H.P., 1500 R.P.M.
- (ii) No. 9 Zerol Gear Bullock Mower with 4'—6" cutter bar, vertical hand lift, ox hitch, parts with reaping attachments.
- (iii) Allis-chalmer Disc Harrow, 20 Discs, 18" dia.
- (iv) Blade terracer.

Advisory : Enquiries were received throughout the year, from both the State Governments and the public. The queries pertained to various aspects of Agricultural Engineering but the majority of correspondents including the State Governments sought our advice on suitability of certain types of agricultural machinery and implements. Many enquiries on the implements designed and developed by this Division were also answered.

The Head of the Division of Agricultural Engineering, continued to perform the duties, which were previously being carried out by the Director of Agricultural Machinery in the Ministry of Food & Agriculture, in addition to his own. The Ministry of Food & Agriculture, Govt. of India, consulted the Head of the Division of Agricultural Engineering on all matters connected with Agricultural Engineering and import control of agricultural machinery and implements.

The following are some of the important recommendations made to the Ministry of Food & Agriculture. Information was collected and supplied with regards to standardising tractor tyres and tubes with a view to facilitate their production in India. A

list of inter-changeable and non-interchangeable spare parts for agricultural implements and tractors was prepared for the information of the customs authorities. Details were given regarding attachments and accessories to be allowed free import along with agricultural tractors. General specifications were prepared for the tractors which should be allowed import into India and certain relaxations in the present import policy were also recommended. To ensure after-sales-service and maintenance of tractors, certain minimum standards of workshop equipment and staff for tractor importers were laid down. The question of allowing a rebate on the customs duty of imported petrol when used for agricultural operations was brought to the attention of the Ministry of Food & Agriculture.

Information regarding Indian indigenous agricultural implements, their description, illustration, functions and uses was sent to the Belgian Embassy, at their request for introduction of these implements in Belgian Congo.

Training : (1) Theoretical and practical classes, pertaining to Agricultural Engineering of the first year Post-Graduate Students of the Division of Agronomy, were taken as usual. Theory and practical classes for the students of the C.C.A. were also conducted.

(2) A six weeks' training course in Mechanised Agriculture was organised and was formally inaugurated, in the presence of a large distinguished gathering, by the Minister of Food & Agriculture, Govt. of India in this Division. The classes were conducted by Mr. Earl K. Rambo, American Expert in Agricultural Engineering with the help of Engineers of Indian importing firms and the staff of the Division of Agricultural Engineering at the I.A.R.I. The course was attended to by 28 trainees from several States of India.

Visitors : Visitors from India as well as foreign countries, including Govt. Officials and public leaders, visited this Division during the year. Many farmers and zamindars, interested in mechanised farming, were explained of the utility of various agricultural machinery and implements, during their visits. The Division had also received the following distinguished visitors :—

1. Shri K. M. Munshi, Former Minister of Food & Agriculture, Government of India.
2. Shri Mohd. Natsir, Former Prime Minister of Republic of Indonesia.
3. Mr. F. Hansen, F.A.O., Rome.
4. The Commander-in-Chief of Indian Army.

Museum for Agricultural Machinery and Implements :

It has been decided, at the instance of the Ministry of Food & Agriculture, to open a Museum of Agricultural Machinery and Implements, now being used in different parts of India and abroad, at this Institute. A beginning has been made and some indigenous implements have been collected and exhibited in the implement shed of the workshop. A circular letter has also been sent to all leading firms dealing with agricultural implements, requesting them to supply implements which would be worth exhibiting. On receipt of their replies, arrangements to procure the equipments will be made.

Research and field trials

1. *Experiments on Seed Drills* : (a) A single row planter was experimented upon with maize seeds. At the first trial it worked satisfactorily so far as the seeding was concerned, but the land wheels were observed to be getting clogged. Some modifications have been carried out to remove this difficulty. The seed selector mechanism of this drill is also suitable for groundnuts.

(b) An indigenous planter, known as "*Argadha*" in Madhya Pradesh, has been converted into an automatic mechanical seed drill and was tried in the field with cow-peas seeds. The performance of the machine was satisfactory. It gave a seed rate of 8 seers per acre when the opening of the feed roller was at its minimum. The necessary seed rate of 12 seers per acre was obtained when the opening of the roller was increased. Time taken to sow one acre of land with this machine was 100 minutes.

While taking this machine to the field it was noticed that the help of an extra man besides the ploughman was necessary to turn the land wheel, which was a hollow steel roller. The turning of the land wheel was necessary to facilitate its movements on the road. No other difficulty was found with the machine.

2. *Trial of Japanese rice land weeder* : Single row and two-row rice land weeders operated manually have been obtained from Japan for experimental purpose. The two-row weeder was tried at Pusa (Bihar) in the rice fields, which had been transplanted earlier with 12" gap between rows. The weeder is designed to work for row width of 9" and over. The implement worked successfully in fields with standing water of 1" to 2" depth and it removed all the weeds without injuring the rice plants. In rice land where moisture content was about 20 per cent. its operation was not good. The machine was worked in a field of 1/25 acre in area. It takes 5 hours to weed one acre of rice land where the plants are in rows. Continuous operation for more than an hour by a man is possible. The work with this implement is less tiresome than present "*Khurpi*" and its output is also more. Planting rice in rows, is however, a pre-requisite for use of this implement.

3. *Seeding paddy in mechanical seed drill* : A five row British Seed Drill which could be hauled in the field by a pair of bullocks was tried in a 1/25 acre plot for seeding paddy in rows at Pusa (Bihar). The seed drill was tried in dry land which had been well prepared and water was let in to the land after seeding. The following are the specifications of the machine :—

Width of seed drill	...	...	3 ft. (approx.).
Number of rows	...	...	5
Width between rows	...	...	8" (adjustable).
Seed Rate	...	...	48 lbs. per acre.

The '*Sohag*' or the land leveller was run after seeding but before the water was let in. The coulters were adjusted to place the seeds at 1½" to 2" below ground level. The purpose of this experiment was to study if paddy could be seeded in rows by using machines.

4. *Trial of Peter AVI Diesel Engines* : A 5 B.H.P. diesel engine, which was presented to the Central Minister of Food & Agriculture by Messrs. Parry & Co., was tried at this Institute. The engine was tried after providing a radiator to the cooling system. At the first test the exhaust valve of the engine had given way due to some manufacturing defects and certain other parts were also damaged as a result of this. The engine was reconditioned by the firm at their own cost, and since then it has been working a hammer mill satisfactorily for crushing oats. The average requirements of power for this mill is 3-4 H.P. and the output obtained has been at the rate of 2-3 maunds per hour. The force system of the lubrication and solid injection devices provided on this engine have shown no sign of trouble and the consumption of diesel oil has been found approximately 2.66 pints per hour, which seems quite economical. There was no appreciable rise in temperature and the engine maintained constant speed during test.

5. *Trial of sub-soiler plough* : A sub-soil plough manufactured by Messrs. Charmes Forden Toulesc Channy and supplied to this Division by Messrs. Bhagwan Das & Co., for trial was subjected to the field tests with an "*Oliver 60*" tractor, run on powerine.

The trial was conducted on hard as well as soft soils in the Institute Farm. It has been observed that this plough cannot be worked by bullock power as the draft is very heavy and is only suitable to be used as tractor drawn implement. A comparative test figures on dry and moist soils are given below :—

Tractor	Selected gear	Nature of soil.	Furrow		Output in acre/hour	Draft in Lb.	Speed per hour in miles.	Fuel consumed in gallons/hour.
			Depth	Width				
Oliver 60' 16 DBHP run on powerine.	1st	Sandy loam with jowar stubbles, moisture contents 3% (dry).	12"	8"	0.21	1,750	1.80	2.00
Do.	1st	Sandy loam with jowar stubbles, twice disced, moisture contents 6% (soft).	12"	9"	0.26	1,250	1.90	1.20

6. *Bullock drawn power reaper* : A bullock-cum-power operated reaper has been designed and fabricated by this Division. The machine is hauled by a pair of bullocks but the cutter bar mechanism is operated by a small engine. Preliminary tests of the reaper have been carried out successfully. During the trials it was observed that the mild steel hinger plate, for raising and lowering the cutter bar bent some times due to its weak structure. It has now been replaced by a stronger one of massive and rigid structure.

7. *Power thresher for paddy* : A power operated paddy thresher, on the model of Japanese pedal operated one, has been designed and manufactured. The machine was put to test at the Agricultural Sub-Station, Karnal. The performance of this machine was found to be better than that of the Japanese pedal operated one, which was also tested simultaneously for the sake of comparison. It was also observed that output and cost of threshing with power thresher of our manufacture is decidedly better and cheaper. The results of test are tabulated below :—

Machine	Men engaged with trial	Average output in mds/hour.	Average fuel consumption per hour (Petrol)	Cost of threshing per md. in rupees.
Japanese Pedal operated thresher.	2	0.975	..	0.50
Thresher built in our workshop (run by a small petrol engine).	2	8.125	0.60	0.31

8. *Bund Former* : Trials of the bund former were carried out for making bunds in the field. It was found that a bund former can make 6,000 ft. of bund per hour, 7" high in soil containing 1.5 per cent. moisture. A Victory Plough used for the same purpose makes 3,000 ft. of bund per hour of almost the same height. Pull in each case was less than 200 lbs., since this was in ploughed field and the bullocks were able to work both these implements without any sign of fatigue. The bund former is a common bullock implement used in the ceded districts of Madras.

9. *Bakhar* : A bullock drawn implement, known as *Bakhar* which is generally used for ploughing in Madhya Pradesh was tried at the Institute farms with a view to examine its utility and adaptibility for alluvial soils under local conditions. It was

observed during the tests, that a *Bakhar* of 15" width and drawn by a pair of bullocks, was capable of ploughing 1.85 acres in 8 hours to a depth of 4". This output is practically three times of that of an ordinary Desi Plough. In subsequent operations, it can plough about 2.50 acres in 8 hours. *Bakhar* is a blade-harrow, generally used in the clay soils of India.

10. *Guntaka* : The advantages in the use of a *Guntaka*, which is, in fact, an improved form of *Bakhar* is that its blade can be adjusted to any desired angle for obtaining different depths of ploughing. This implement is generally used in South India, but was tested in sandy loam soils of the Institute Farm, containing 2.25 per cent moisture. The field had been irrigated previously and the sugarcane stubbles were removed before the operations. A *Guntaka* having a blade of 12"×2½" and adjusted to a depth of 4" showed a draft of 150 lbs. on the dynamometer. The average output was found to be 0.20 acres per hour, which is more than 3 times of that generally obtainable by a local plough. The *Guntaka* works well in soft soils but does not penetrate the harder soils.

11. *Test of Tata Plough Shares* : The plough shares, manufactured by Messrs. Tata and Co., Jamshedpur were fitted to the Delhi type of country plough bottoms and were used in the I.A.R.I. farms. The total number of hours to which they were subjected to use were 550 and it was noticed that they were worn out by 1/2" in length during the tests. The performance was generally satisfactory but the share points had to be sharpened once during the whole working period. The quality of steel used in the manufacture of share points, seems to withstand the rough use to which these shares are subjected to, during the ploughing operations.

12. *Trial of Bone-Digester* : At the instance of the Ministry of Food & Agriculture, a trial of bone-digester, manufactured in Japan was arranged. The digester was heated on a furnace, designed and constructed by Bawa Chetan Das of Banaras, which could bring up the required working pressure of 60 lbs. by consuming low grade fuels like straw and saw dust. In the first test, when the digester contained about 8 gallons of water only, the working pressure was produced in 52 minutes, consuming 8 seers of straw. In second test 7 seers of bones with suitable quantity of water were put into the digester and the working pressure was obtained in 70 minutes after burning 11 seers of straw. After cooling down the digester, the bones were found to be weighing 9 seers and had become so soft that they could easily be turned into dust by hand pounding.

13. *Experiment on soil tilth* : Proper soil tilth should be obtained before any crop is sown into the field. Experimentation is required to determine the number of cultivations needed in certain type of lands for particular crops to attain the correct soil tilth as both excessive as well as inadequate cultivation may be damaging to the interests of the crops. To determine the exact number of times of ploughing, discing and grubbing required to obtain correct tilth in the soil for a particular type of land, experiment has been started by this Division and has so far been carried out on 27 plots, measuring 900 sq. yds. each. The composite samples of soils have been collected for their analysis.

14. *Jute Seed Drill* : In spite of our having many varieties of seed drills both—indigenous and foreign—in our country, no proper machine for sowing jute seeds is yet available. As the jute is one of our main cash crops, it is imperative to evolve some means by which the cultivating methods of this important crop can be improved and with this object in view, a research project for developing a seed drill for sowing jute, has been started. The machine has been designed and a considerable progress has been made in its manufacture. The frame work, wheel axle, seed picking and dropping mechanism and chain and sprocket drive through clutch, have already been fabricated. The other component parts are also under manufacture and the machine is expected to be ready for tests during next season.

Intensive cultivation

43.51 acres of land was ploughed with a tractor in the village of Qamaruddin Nagar, under the Delhi Intensive Cultivation scheme. Eleven workers, headed by the Workshop Foreman, had visited the same village in connection with pohl eradication work.

Programme of work for the year 1952-53

1. Continued experiments on Peter Oil Engine to be tried with mustard oil.
2. Trials of Japanese grain screen, seeders, etc.
3. Experiments on soil tilth.
4. Formation of Museum and Agricultural Engineers' Conference.
5. Test of the Sigma Centrifugal Pump with the existing hydrants of this Institute.
6. Testing of tractors.
7. Testing of ploughs.
8. Completing jute seed drill.
9. Improvement of hand rotary screen.
10. Investigating the possibility of using heavy disc harrow (Evona) instead of mould board ploughs.
11. Efficiency tests of Madras Water Lift (Mhote).
12. Trials of Ferguson Level Terracer.
13. Trials of 18" Allis-Chalmer Disc Harrow.

APPENDIX I
GAZETTED STAFF
(1951-52)

Director	...	...	...	Dr. B. P. Pal, M.Sc., Ph.D. (Cantab.), F.B.S., F.L.S., F.N.I.
Registrar	...	...	...	Shri J. M. Banerjee, M.A.
Personal Assistant to the Director	...	...	...	Shri K. C. Gupta, B.A. (from 1-9-51).
Librarian (Non-Gazetted)	...	...	...	Shri N. N. Chatterji, B.Sc., Dip.L.S.

Agronomy Division

Head of the Division	...	...	...	Dr. T. J. Mirchandani, M.Sc., Ph.D. (Lond.).
Agronomist	...	...	...	Shri S. Sen, M.Sc. (Cal.).
Agronomist	...	...	...	Dr. P. C. Raheja, M.Sc., (Agric.) (Punjab), Ph.D. (Punjab).
Agronomist	...	...	...	Dr. N. P. Datta, M.Sc. (Cal.), D.Sc. (Cal.), A.R.I.C.
Assistant Agronomist	...	...	...	F/Lt. R. D. Verma, B.Sc. (Punjab), B.Sc. (Edin.).
Assistant Agronomist	...	...	...	Shri A. R. Khan, B.Sc. (Agra), M.Sc. (Wis.).
Assistant Agronomist	...	...	...	Shri J. J. Chandnani, M.Sc. (Ag.) (Punjab).
Assistant Agrostologist	...	...	...	Shri P. M. Dabadghao, M.Sc. (Nagpur).
Assistant Statistician	...	...	...	Dr. P. N. Saxena, M.A., Ph.D.

Botany Division

Head of the Division	...	...	...	Dr. N. Parthasarathy, B.Sc. (Madras), B.A. (Ag.), Ph.D. (Lond.), F.N.I.
Plant Physiologist	...	...	...	Dr. R. D. Asana, M.Sc. (Bombay), Ph.D. (Lond.), D.I.C.
Cytogeneticist	...	...	...	Dr. P. N. Bhaduri, M.Sc. (Cal.), Ph.D. (Lond.), F.L.S., F.R.M.S., F.N.I., F.B.S.
Systematic Botanist	...	...	...	Dr. D. Chatterjee, M.Sc. (Cal.), Ph.D. (Edin.), F.L.S. (Lond.), F.B.S.
Geneticist	...	...	...	Mr. R. B. Deshpande, M.Ag. (Bombay), Assoc., I.A.R.I.
Wheat Breeder (Co-ordinated Wheat Rust Control Scheme).	...	...	...	Dr. G. S. Murty, M.Sc. (Lucknow), Assoc. I.A.R.I., Ph.D. (Minn.) (from 1-2-52).
Assistant Geneticist	...	...	...	Dr. F. H. Abbasi, B.Sc., Ph.D. (Minn.).
Assistant Cytogeneticist	...	...	...	Dr. A. B. Joshi, M.Sc. (Nagpur), Assoc. I.A.R.I., Ph.D. (Cantab.).
Assistant Botanist (Plant Introduction Scheme).	...	...	...	Shri H. B. Singh, M.Sc. (Agra), Assoc. I.A.R.I.
Assistant Plant Physiologist	...	...	...	Shri T. J. Malkani, M.Sc. (Bombay).
Assistant Wheat Breeder (Co-ordinated Wheat Rust Control Scheme).	...	...	...	Shri S. Sen, M.Sc. (Cal.).

Soil Science and Agricultural Chemistry Division

Head of the Division	...	...	...	Dr. S. P. Raychaudhuri, M.Sc. (Calcutta), Ph.D. (Lond.), D.Sc. (Cal. & Lond.), F.R.I.C., F.N.I.
Soil Microbiologist	...	...	...	Dr. S. V. Desai, B.Sc., Ph.D., D.Sc., D.I.C. (upto 5-11-51).
				Dr. N. D. Vyas, M.Sc., Ph.D. (from 19-5-52).

Soil Survey Officer	...	...	Dr. R. V. Tamhane, B.Ag. (Bombay), Ph.D. (Lond).
Biochemist	...	...	Dr. N. B. Das, Ph.D.
Organic Chemist	...	...	Dr. K. C. Gulati, B.Sc. (Hons. Tech.), M.Sc. (Hons.), Ph.D. (Punjab).
Experimental Physicist	...	...	Dr. C. Dakshinamurty, M.Sc., Ph.D. (Lond.), D.Sc. (Banaras), F.Inst. P.
Assistant Soil Microbiologist	...	...	Dr. N. D. Vyas, M.Sc., Ph.D. (upto 18-5-52).
Assistant Soil Survey Officer	...	...	Dr. K. V. S. Satyanarayana, B.Sc. (Agric.), Ph.D. (Madras), Assoc. I.A.R.I.
Assistant Soil Survey Officer	...	...	Shri L. M. Mathur (Offg.), M.A., B.T. (Aligarh), A.S.T.
Assistant Organic Chemist	...	...	Dr. A. C. Bose, B.Sc. (Hons.), Ph.D. (Liverpool), A.I.C.
Assistant Organic Chemist	...	...	Dr. A. R. S. Kartha, M.Sc., Ph.D. (from 15-12-51).
Assistant Physical Chemist	...	...	Dr. B. B. Roy, M.Sc., Ph.D. (Durham), A.R.I.C. (Lond.).
Assistant Soil Chemist	...	...	Dr. C. N. Acharya, Ph.D. (Lond.), D.Sc. (Lond.), F.R.I.C.
Assistant Agricultural Chemist	...	...	Shri M. A. Idnani, B.Sc. (Hons.), Assoc. I.A.R.I.
Assistant Soil Physicist	...	...	Dr. B. T. Mulwani, B.Ag., M.Sc., Ph.D. (Lond.), D.I.C. (Offg.).

Mycology and Plant Pathology Division

Head of the Division	...	...	Dr. R. S. Vasudeva, D.Sc. (Lond.), Ph.D. (Lond.), D.I.C., F.N.I.
Systematic Mycologist	...	...	Dr. B. L. Chona, Ph.D. (Lond.), D.I.C. (from 26-7-51).
Mycologist (Co-ordinated Wheat Rust Control Scheme).	...	...	Dr. R. Prasada, M.Sc., D.Sc. (Agra) (from 5-5-52).
Assistant Systematic Mycologist	...	...	Dr. B. L. Chona (upto 25-7-51).
Assistant Plant Pathologist	...	...	Dr. R. Prasada (upto 5-2-52).
Assistant Virologist	...	...	Dr. S. P. Raychaudhury, M.Sc. (Cal.), D.Phil. (Cal.), F.L.S., Assoc. I.A.R.I. (On study leave to U.S.A.).
Assistant Plant Pathologist	...	...	Dr. M. L. Gattani, M.Sc. (Agra), Ph.D. (Minn.), (On deputation to Rajasthan Govt.).
Assistant Plant Bacteriologist	...	...	Dr. M. K. Hingorani, B.Sc. (Agric.), Ph.D. (Minn.), Assoc. I.A.R.I.
Assistant Plant Pathologist	...	...	Dr. R. S. Mathur, M.Sc., Ph.D. (W.Va.), Assoc. I.A.R.I.

Entomology Division

Head of the Division	...	...	Dr. E. S. Narayanan (offg.), M.A., Ph.D. (Lond.), D.I.C., F.R.E.S., F.E.S.I.
Systematic Entomologist	...	...	Dr. S. Mukherjee, M.Sc., D.Sc.

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Insect Ecologist	...	...	Dr. S. Pradhan, M.Sc., Ph.D. (Lond.), D.Sc., F.R.E.S., F.E.S.I.
Assistant Systematic Entomologist	...	...	Shri B. B. Bose, B.Sc., F.E.S.I.
Assistant Systematic Entomologist	...	...	Shri C. K. Samuel, B.Sc. Assoc., I.A.R.I., F.E.S.I.
Assistant Insect Epidemeologist	...	...	Dr. R. P. Chaudhury, M.Sc. (Cal.), Ph.D. (Lond.) (upto 16-8-51).
			Shri T. V. Venkataraman (offg.) (from 24-3-52).

Agricultural Engineering Division

Head of the Division	...	...	Shri R. V. Ramiah, B.E. (Mech.), M.Sc. (Iowa), M.A.S.A.E.
Assistant Engineer	...	...	Shri A. K. Kaul, I.E.E.
Assistant Engineer	...	...	Shri J. S. Manku, B.Sc. (Elec. & Mech. Eng.), A.M.I.E. (India), Assoc. Mem. A.S.A.E.

Agricultural Sub-Station, Karnal

Assistant Agronomist	...	...	Shri B. D. Ganguly, B.Sc. (Ag.).
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Botanical Sub-Station, Pusa (Bihar)

Superintendent	...	...	Shri M. D. Nandkeolyar, M.Sc. (Banaras).
Assistant Wheat Breeder	...	...	Shri S. Kedharnath, M.Sc. (Madras).

Co-ordinated Wheat Rust Control Scheme, Simla

Assistant Wheat Breeder	...	...	Dr. S. P. Kohli, M.Sc. (Punjab), Ph.D. (Cornell).
Assistant Mycologist	...	...	Shri V. C. Lele, M.Sc. (from 5-2-52).

Central College of Agriculture

Principal	...	...	Vacant.*
Lecturer in Agriculture	...	...	Dr. J. Singh, B.Sc., Agric. (Punjab), Ph.D. (Wales).
Lecturer in Chemistry	...	...	Dr. W. B. V. Sundara Rao, M.Sc., Ph.D. (Bombay), Assoc. I.A.R.I.
Lecturer in Entomology	...	...	Dr. Sardar Singh, B.Sc. (Agric.), Ph.D. (Cornell).
Lecturer in Physics	...	...	Dr. Y. V. Kathavate, M.Sc., Ph.D.
Lecturer in Agricultural Engineering	...	...	Shri J. R. Badola, B.Sc. (Agric. Eng.).
Lecturer in Veterinary Science	...	...	Dr. Gian Singh, L.V.P. (Hons.) (Punjab), P.G. (I.V.R.I., Mukteswar).
Lecturer in Horticulture	...	...	Dr. G. S. Randhawa, M.Sc., M.S. (Toronto), Ph.D. (Michigan).
Lecturer in Mycology	...	...	Shri S. D. Gera, M.Sc. (Punjab) (upto 6-4-52).
			Dr. D. Suryanarayana, M.Sc. (Agra), Ph.D. (Agra) (from 7-4-52).

* Current duties of the Principal, C.C.A. is partly done by the Director, I.A.R.I. and partly by Dr. T. J. Mirchandani, Head of the Division of Agronomy.

APPENDIX II

Training of Students and Research Workers during 1951-52

(a) List of students awarded the Post-graduate Diploma :—

Division of Botany

Name of students				Subject of thesis
Shri H. K. Jain	...	...	...	Inheritance study in F_1 of intervarietal crosses in <i>linum usitatissimum</i> and F_2 of species crosses in <i>Linum</i> .
Shri W. P. Sole	...	...	...	Study of relationship between rust (<i>Melampsora lini</i>) resistance and morphological and anatomical characters in <i>Linum</i> .
Shri R. N. Patnaick	...	...	...	Taxonomical and inheritance studies in <i>Solanum melongena</i> and related species.
Shri S. L. Gupta	...	...	...	A study of synthetic growth regulators in the growth and development of wheat.
Shri B. S. Murthy	...	...	...	A study of lodging in four varieties of wheat.
Shri N. Y. Deshmukh	...	...	...	Studies on the autotetraploids of linseed with special reference to their utilisation in breeding.
Shri P. L. Samayajulu	...	...	...	Studies in hill wheats.
Shri M. N. Ahluwalia	...	...	...	(a) A study of the different methods of induction of polyploidy by colchicine to cereals. (b) Cytogenetical studies of some derivatives of intergeneric hybrids of <i>Triticum</i> and allied genera.

Division of Agronomy

Shri Sardar Singh	...	...	...	Mixed cropping Rabi (New).
Shri S. S. Pathak	...	...	...	Effect of different forms of phosphates on berseem and residual effect on maize.
Shri L. B. Singh	...	...	...	Green manuring experiment on wheat (Time of burying <i>S. hemp</i> with and without fertilizer).
Shri P. K. Panigrahi	...	...	...	Building up of soil fertility through different forms of organic manures with and without inorganics.
Shri C. B. Agnihotri	...	...	...	Cultural-cum-varietal experiment on cane.
Shri R. K. Sharma	...	...	...	Varietal-cum-manurial experiment on cane.
Shri S. D. Nimkar	...	...	...	Cultural experiment on cotton.
Shri C. S. Sirohi	...	...	...	Response curve of nitrogen with wheat (inorganic).
Shri S. K. Nigam	...	...	...	Effect of different forms of Nitrogen on wheat.
Shri S. S. Awasthi	...	...	...	Availability of nitrogen in F.Y.M., Cakes, Sulphate of Ammonia.

Division of Agronomy—contd.

<i>Name of student</i>			<i>Subject of thesis</i>
Shri R. B. L. Bharadwaj	...	...	Effect of low doses of phosphate on Berseem.
Shri P. K. Khedekar	...	...	Varietal experiment with Linseed.
Shri L. Misra	...	...	Manuring of potatoes
Shri S. C. Chaudhury	...	...	Cultivation-cum-manurial experiment in a rotation of maize, berseem fallow wheat.
Shri S. P. Sharma	...	...	Tillage experiment on wheat.
Shri R. D. Kaushik	...	...	Mixed cropping Rabi (Old).
Shri S. S. Tiwari	...	...	Seed mixture experiments with grasses.
Shri A. K. Chaudhury	...	...	Phosphatic manuring of berseem with and without potash and nitrogen and its residual effect on maize, wheat and jowar.

Division of Chemistry

Shri Ambadas Rao	...	...	Study of black soil of Bhopal.
Shri C. P. Gupta	...	...	Studies on the saline soil from Delhi.
Shri M. S. Rawat	...	...	Soil and land use survey of Bhangur tracts of Delhi.
Shri N. M. Nimgade	...	...	Reclamation of saline and alkaline land in Delhi.
Shri M. Farooque	...	...	Effect of Singbhum phosphate on soil microflora and on crops.

Division of Entomology

Shri S. B. Lal Gupta	...	...	The Biological studies on a Syrphid predator on Aphids at Delhi.
Shri K. D. Menon	...	...	Biology and External Morphology of <i>Iscecocrus</i> sp. (Hemiptera).
Shri M. Govindan	...	...	Effect of Temperature on the susceptibility of insects to fumigation.
Shri B. M. Patnaik	...	...	Studies on the Biology and control of <i>Rhopalosiphum pseudobrassicae</i> Dairs.
Shri R. S. Bhatnagar	...	...	Loss of water from insect body under different physical and chemical environment.
Shri K. C. Chandy	...	...	Studies in host selection by <i>Microbracon gelechia</i> , a larval parasite of the potato tuber moth larva <i>Gnorimoschema operculella</i> .

Division of Mycology and Plant Pathology

Shri C. V. Govindaswamy	...	...	Interaction of soil saprophytes in relation to pathogenicity of <i>Fusarium udum</i> .
Shri Naresh Chand	...	...	Fungal flora of Delhi.
Shri V. V. Chenulu	...	...	Inheritance of pathogenicity in <i>Malamp-sora lini</i> , Indian physiologic races 1 and 2.

Division of Mycology and Plant Pathology—contd.

<i>Name of student</i>	<i>Subject of thesis</i>
Shri Harjinder Singh	Perpetuation and host range of pea rust.
Shri Y. K. S. Murty	Fungus flora of stored seed grains of Bajra, Jowar and Barley, its correlation to seed rotting and pre-emergence injuries and beneficial effect of fungicidal treatment.
Shri S. K. Addy	Comparative cultural and pathogenicity studies of Bacteria associated with soft rot of potatoes.

(b) Students admitted during the year :—

Agronomy

- | | |
|---------------------|----------------------|
| 1. I. R. Babu. | 9. N. K. Shinde. |
| 2. A. K. Majumdar. | 10. Y. R. Mahajan. |
| 3. K. T. Bhagat. | 11. M. S. Choudhury. |
| 4. S. Ajit Singh. | 12. P. C. Kapoor. |
| 5. N. K. Chopra. | 13. N. P. Wankhado. |
| 6. M. M. Ramji. | 14. Ba Khin. |
| 7. M. Alam. | 15. S. K. Bose. |
| 8. R. A. Choudhury. | 16. R. D. Prasad. |

Botany

- | | |
|----------------------|-----------------|
| 1. N. G. Prasad Rao. | 6. M. Narhari. |
| 2. B. S. Degar. | 7. P. N. Ghosh. |
| 3. N. K. Bajpayae. | 8. S. P. Singh. |
| 4. G. Rama Rao. | 9. D. N. Misra. |
| 5. N. N. Roy. | |

Chemistry

- | | |
|----------------------------|-------------------------|
| 1. Arun Kumar Datta. | 5. S. C. Thippeswami. |
| 2. Bodhisatva Banerjee. | 6. Himat Lal C. Mehta. |
| 3. Vishnu Datt Sharma. | 7. Mohammed Abdul Wali. |
| 4. Parmeshwari Prasad Jha. | |

Entomology

- | | |
|--------------------|------------------|
| 1. M. J. Chako. | 5. O. S. Bindra. |
| 2. H. S. Sangwan. | 6. S. S. Bhatia. |
| 3. M. G. Hardas. | 7. K. S. Rao. |
| 4. P. V. Rangarao. | |

Mycology

- | | |
|---------------------|-------------------|
| 1. G. C. Rangaswami | 4. A. Jha. |
| 2. H. U. Joshi. | 5. J. N. Kapoor. |
| 3. S. M. Gufrav. | 6. P. Kanyansoon. |

(c) Students admitted for short course of training :—

Short Course (Agronomy)

M. P. Guha	...	...	...	3 months.
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Short Course in Soil Survey

1. V. V. Misra.	}	6 months.
2. M. V. Bapat.		
3. B. M. Nanniah.		
4. H. K. Das Gupta.		

(d) Honorary Research Workers :—

<i>Name</i>				<i>Subject of the Problem</i>
M. P. Joseph	...	...	...	Morphology and physiology of Brumer's organ in Aeriididae.
A. K. Das	...	...	...	Minerological make-up of Indian soils and their relation to base exchange reactions.
D. J. Guptoo	...	...	...	Studies on the equilibrium of cation exchange reactions in soils and clay minerals.
C. L. Gupta	...	...	...	Fractionation and study of the nature of organic phosphorus in the soil.
N. M. Nimgade	...	...	...	Fractionation of organic phosphorus of the soil.
I. Dharhi	...	...	...	Potassium fixation in soils.
B. S. Bajaj	...	...	...	Factors responsible for variation in <i>C. falcatum</i> .
Y. K. S. Murthy	...	...	...	Physiology of parasitism.
H. Gurubasavaraj	...	...	...	Effect of micronutrients and phosphates on crop yield, quality and soil fertility

(e) Research Fellows.

1. P. C. Thakur	...	...	...	Chemistry.
2. B. R. Subha Rao	...	...	...	Entomology.
3. M. K. Roy	...	...	...	Chemistry.
4. D. K. Misra	...	...	...	Agronomy.
5. K. K. Pande	...	...	...	Botany.

APPENDIX III

List of Publications during 1951-52

1. Abbasi, F.H. (1951) Hybrid maize. *Indian J. Genet. & Pl. Breed.*, 11 : 185-195.
2. Acharya, C. N. and Jain, S. P. (1952) ... Causative factors of incurred soil fertility after the growth of legumes. *Ind. Sci. Cong. Assoc.*, 1952.
3. Asana, R. D. (1951) Plant Physiology (A review of work done in India during 1949-50). *Annual Review of Biochem. and allied Research in India*.
4. Asana, R. D. (1951) Common Indian weeds and their control. *Indian Farming*, N.S. 1(4) : pp. 13-15 & 20.
5. Bhaduri, P. N. (1951) Interrelationship of non-tuberiferous species of *Solanum* with some consideration on the origin of brinjal. *Indian J. Genet. & Pl. Breed.* 11 : 75-82.
6. Bharadwaj, R. B. L. & Sen, S. ... Manuring of berseem production. *Proc. 39th Ind. Sci. Cong.*, 52.
7. Chandnani, J. J. (1951) Things to do on the farm. *Indian Farming*, N.S. 1(3) : 8. 1(4) : 6, 1(5) : 8, 1(6) : 8, 1(7), 1(8) : 8, 1(9) : 8, 1(10) : 8, 1(11) : 8, 1(12) : 8.
8. Chandnani, J. J. (1951) Grow more wheat. *Ind. Farming*, N.S. 1(7) : 27.
9. Chandnani, J. J. (1951) Cotton Cultivation in Delhi. *Ind. Farming*, N.S. 1(9) : 18.
10. Chandnani, J. J. & Chatterjee, D. (1952) Delhi can grow Jute. *Ind. Farming*, N.S. Vol. 2(1) : 16.
11. Chandnani, J. J. (1952) Some hints on how to grow more paddy. *Ind. Farming*, N.S. 2(1) : 8.
12. Chandnani, J. J. (1952) Some practical hints to farmers to increase production of cotton. *Indian Farming*, N.S. 2(2) : 8.
13. Chandnani, J. J. Scientific manuring of crops in a rotation to build soil fertility. *Proc. 9th meeting Crops & Soils Wing, Bd. of Agri. & Animal Husbandry in India*.
14. Chatterjee, D. (1951) *Strophanthus biovini* Baill. *Hook Icon. Plant.* 5(4) : Ser. 5 ; tab. 3483.
15. Chatterjee, D. (1950) *Mansonia dipikae* Purakayastha *Hook. Icon. Plant.* 5(4) : Ser. 5 ; tab. 3484.
16. Chatterjee, D. (1951) Note on the origin and distribution of wild and cultivated rice. *Indian J. Genet. & Pl. Breed.* 11 : 18-22.
17. Chatterjee, D. (1951) Plea for improvement of nomenclature of horticultural plants. *Ind. J. Hort.*, 8 : 14-16.
18. Chatterji, S. M. (1952) A note on the occurrence of *Triphleps* sp. ; (Hemiptera : Anthocoridae), a hitherto unrecorded predator of stored grain pests in India, *Curr. Sci.* 20, pp. 240-41.

19. Dabadghao, P. M., Gandhi, R. T. & Wadhwa, N. D. (1951) *Phalaris minor* Rezt., a new promising rabi fodder. *Sci. & Culture*, 17 : 111—115.
20. Das, N. B. & Banerjee, R. M. (1951) .. Utilisation of mango-seed kernel as a source of starch. *Sci. & Culture*, 17 : 339.
21. Datta, N. P. & Bains, S. S. Green manuring in relation to some physical properties of the soil. *Proc. 9th meeting, Crops & Soils Wing, Bd. of Agri. & Animal Husbandry in India*.
22. Datta, N. P. Irrigation and water requirement. *9th meeting of the Crops & Soils Wing, Bd. of Agri. & Ani. Husb. in India*.
23. Datta, N. P. & Gurubasavaraj, H. (1952) Phosphatic fertilisation of berseem—influence of boron and molybdenum. *Proc. Ind. Sc. Congress*.
24. Datta, N. P. (1952) Micronutrient deficiencies in crops in relation to some Indian soils. *Symposium on Soil Research organized by the National Instt. of Sciences of India*, 52.
25. Desai, S. V. & Sen, A. (1952) ... Nitrogen economy in crop rotation without manures. *Sci. & Culture* 17 : 323—325.
26. Deshpande, R. B. & Jeswani, L. M. (1951). Inheritance of resistance to rust (*Melampsora lini* Pers.) *Indian J. Genet. & Pl. Breed.* 11 : 196—204.
27. Harikishore (1951) A note on the chromosome numbers of some plants. *Indian J. Genet. & Pl. Breed.* 11 : 217.
28. Hingorani, M. K. (1951) The effect of temperature and light on the Mesothetic reaction of Jostram. Oats to stem Rust. *Indian Phytopath.* 4(1) : 35—87, 1951.
29. Idnani, M. A. & Chibber, R. K. (1952) Utilisation of wild legumes for green manuring. *Proc. Ind. Sci. Congr. Assoc.*
30. Kaul, R. N. & Raheja, P. C. (1952) ... A review on weed and their control. *Symposium on weeds & their control arranged by the Ind. Sci. Cong.*
31. Khan, A. R. (1951) Irrigation and Crops. *Ind. Farming*, N.S. 1; No. 7.
32. Khan, A. R. (1952) Food for the millions. *Rural India*, 15 : No. 1.
33. Khan, A. R. (1952) Green manuring for better crop production. *Ind. Farming*, N.S. Vol. 2, No. 3.
34. Manku, J. S. Review of "Servicing & Maintenance of Farm Tractors".
35. Mathur, R. S. (1951) A possible function of spore matrix in *Collectotrichum lindemuthianum*. *Indian Phytopath.* 4(2).
36. Mirchandani, T. J. & Sen, S. (1952) ... Role of phosphates in agriculture. *Proc. 39th Ind. Sci. Congress*.
37. Misra, L. & Sen, S. (1952) Effect of different doses of nitrogen and phosphorus and their placements on potatoes. *Proc. 39th Ind. Sci. Congr.*

38. Mukherji, D. K. (1951) Seed testing of samples of food grains
Indian Farming, 12 : 8—14.
39. Mukherji, S. (1952) On a new species of Scelionid (*Hymenoptera* : *Proctotrypoidea*) parasitic on the egg pods of *Hieroglyphus nigrorepletus* Bol. *Indian J. Ent.*, 14, 1952.
40. Murty, G. S. & Deshmukh, M. J. (1951) Trials of improved wheat varieties in India. *Indian J. Genet. & Pl. Breed.* 11 : 136—184.
41. Narayanan, E. S. and Venkatraman, T. V. (1951). Identity of *Scirpophaga* species associated with sugarcane in India (*Lepidoptera* : *Pyrilidae*). *Curr. Sci.*, Nov., 1951, pp. 299-300.
42. Narayanan, E. S., Venkatraman, T. V. & Subba Rao, B. R. (1951). Discovery of hyperparasite on *Stenobracon deesae* Cam. *Curr. Sci.*, Nov. 1951, pp. 300-301.
43. Narayanan, E. S. & Rattan Lal (1952) Informations on the control of termites damaging crops in India with results of experiments carried out at Delhi. *Indian J. Ento.*, 14 :
44. Pal, B. P., Murty, G. S. & Khan, H. R. (1950).* Registration of improved wheat varieties in India. *Indian J. Agric. Sci.*, 20 : 165—172.
45. Pal, B. P. & Singh, H. B. (1952) Some promising recent introductions of crop varieties. *Indian J. Genet. & Pl. Breed.* 11 : 215-16.
46. Pal, B. P., Singh, H. B. & Swarup, V. Taxonomic relationships and breeding possibilities of species of *Abelmoschus* related to okra (*A. esculentus*). *Bot. Gaz.*, 1952, 113 : 455—64.
47. Parthasarathy, N. (1951) Chromosome elimination in *Saccharum*. *Nature*, Lond., 168 : 383.
48. Parthasarathy, N. (1951) Some cytogenetical aspects of the origin of sugarcane. *Indian J. Genet. & Pl. Breed.*, 11 : 63—66.
49. Pradhan, S. & Srivastava, H. M. L. (1951). Physical performance of a laboratory dusting apparatus. *Indian J. Ento.*, 13(2), 209—220.
50. Pradhan, S. & Pradhan, Shanti (1951) Principles of chemical control of insect pests (in Hindi). *Kheti*, 4(4) : 157—159.
51. Pradhan, S. (1952) Chemical warfare against insect enemies of crops. *Indian Farming*, N.S. 2(1) : 14-15.
52. Prasada, R. (1951) Rust on wild grasses. *Current Science*, 20(9) : 243.
53. Ramamurthi, B., Chatterjee, B. G., Dakshinamurti, C. & Gulati, K. C. (1952). A note on rapid and routine method for the estimation of Nicotine in Tobacco. *Nature*, 169 : 112.

* The publication appeared during the period under report.

54. Ramanujam, S. & Joshi, A. B. (1951) ... The use of wild species in breeding improved varieties of cultivated til (*Sesamum orientale* L.), and some consideration on the origin and distribution of *S. orientale*. *Ind. J. Genet. & Pl. Breed.* 11 : 100—105.
55. Raheja, P. C. ... Role of rural leadership in the development of intensive cultivation. *9th meeting of the Crops & Soils Wing, Bd. of Agric. & Ani. Husb. in India.*
56. Raheja, P. C. ... Soil conservation practices under irrigation in D.V.C. : *Symposium on soil conservation arranged by D.V.C.*
57. Ramiah, R. V. (1951) ... Improving Agricultural Implements for Indian Farmers. *Indian Farming*, N.S 1 : November.
58. Ramiah, R. V. (1951) ... Japanese Threshing Machine. *Indian Farming*, N.S. 1.
59. Randhawa, G. S. & Singh, Daljit (1951) Strawberry culture in India. *Ind. J. Hort.*, 8 : 49—53.
60. Randhawa, G. S. (1952) ... Purchasing nursery trees. *Food and Farming*, 4 : 189—190.
61. Rattan Lal (1951) ... Biology and control of *Myzus persica* (Sulz.) as a pest of potato at Delhi. *Indian J. Agric. Sci.*, 20 : 87—100 (1950), '51.
62. Rattan Lal (1952) ... Effect of Malnutrition due to crowding and starvation of alate parents on the production of alate offspring among aphids. *Indian J. Ent.*, 14 : 1952.
63. Raychaudhuri, S. P. (1950) ... Soils & Fertilisers (Review). *Soc. Biol. Chemists, Indian Annual Review of Biochemical and allied Research in India* : 21 : 1—9.
64. Raychaudhuri, S. P. (1951) ... Soil conservation survey. *Proc. Irri. Board, Simla, July, 1951.*
65. Raychaudhuri, S. P. (1951) ... Soil Erosion. *Ind. Farming*, N.S., Aug., '51, 1 : 24-25.
66. Raychaudhuri, S. P. (1951) ... Chemical fertilisers and soil productivity. *Proc. Symposium on chemical in Agriculture*. July, 1951, Poona, p. 2.
67. Raychaudhuri, S. P. (1951) ... The role of artificial fertilisers in increasing crop production. *Sindhri number of the "Hindustan Standard"*.
68. Raychaudhuri, S. P. and Subbiah, B. V. (1951). Soil Survey & Rapid Soil Tests. *Proc. Irri. Bd., Simla, July, 1951.*
69. Raychaudhuri, S. P. (1952) ... Fertilisers & Manures. What practical Agriculturist thinks about it. *Indian Farming*, N.S., 2 : May, 1952, Vol. II, 24—26.

70. Raychaudhuri, S. P. & Chatterjee, R. K. (1952). 8 hydroxyquinoline as a reagent for direct determination of aluminium, calcium and magnesium in soil extract. *Ind. Sci. Cong. Assoc. Proc.*, 1952.
71. Roy, B. B. (1951) ... The phosphate reserves in some permanent pasture plots. *Empire J. Expt. Agric.*, 19, 175—184.
72. Satyanarayana, K. V. S. (1952) ... Soils of Cutch & the Rann and their better utilisation. *Proc. Nat. Instt. of Sciences of India*.
73. Satyanarayana, K. V. S. (1952) ... The colloidal matter of sugarcane juice in relation to the clarification of the juice. *21st Proc. Sug. Techn. Assn., India*.
74. Satyanarayana, K. V. S. and Datta, S. C. (1952). Studies on the soils of Cutch IV. Bacteriological analysis of soil profiles. Sulphate reducers. *39th Session Ind. Sci. Congr., Cal., 1952*.
75. Sen, A. & Das, B. (1951) ... Composition of Tank silts from West Bengal. *Sci. & Cult.*, 17 : 93-94.
76. Sen, A. & Das, B. (1952) ... Tank silt as manure for light soils. *Indian Farming*, N.S. 1 : 26.
77. Sen, A. & Bose, A. C. (1952) ... Recovery of cobalt nitrate in the estimation of Potassium by the cobalt nitrite method. *Sci. & Cult.*, 17 : 434.
78. Sen, S. ... The need of agricultural bias in education and an effective means of its early realization. *Proc. 9th meeting, Crops & Soils Wing, Bd. of Agri. & Ani. Husb in India*.
79. Subbiah, B. V. & Desai, S. V. (1952) ... Nitrogen & Phosphorus absorption by wheat. *Curr. Sci.* 21 : (4) ; 100.
80. Subbiah, B. V. & Desai, S. V. (1952) ... Availability of Nitrogen in soils and manures. *Indian J. Agric. Sci.*, 22 : 167—173.
81. Singh, H. B. (1951) ... Sweet potatoes introduced from China. *Indian Farming*, N.S., 1(6) : 28.
82. Singh, H. B. (1952) ... The romance of plant introduction. *Indian Farming*, N.S., 1(10) : 22—24.
83. Tamhane, R. V. (1951) ... Classification of soils. *Proc. Irri. Bd., Simla July, 1951*.
84. Vasudeva, R. S. (1952) ... Sun as a means of controlling wheat rust. *Indian Farming*, N.S. 2(5) : 1952.
85. Vasudeva, R. S. & Chona, B. L. (1951) Fighting Red Rot Epidemic. *Indian Farming*, N.S., 1(6).
86. Vasudeva, R. S., Jain, A. C. & Nema, K. G. (1952). Inhibition of *Fusarium udum* Butler, the fungus causing wilt of pigeon-pea *Cajanus cajan* (L) (Millsp.) by *Bacillus subtilis*. *Ann. Appl. Biol.*, 39(2) : 229—238.

87. Vasudeva, R. S. & Azad, R. N. (1952) ... Efficacy of certain fungicides against potato late blight and assessment of loss due to the disease. *American Potato Journal*, 29(3) : 61—71.
88. Vasudeva, R. S. & Hingorani, M. K. (1952). Bacterial disease of wheat caused by *Corynebacterium tritici* (Hutchinson) Bergey *et al.* *Phytopathology*, 42(6) : 291—293.
89. Vasudeva, R. S. & Hingorani, M. K. (1952). Tannan or Tundu disease of wheat. *Indian Farming*, N.S., 2(3) : 14.
90. Verma, R. D. (1952) ... Hints to Farmers on maize, Jowar & Bajra. *Indian Farming*, N.S., 2(4) : 6.
91. Verma, R. D. (1952) ... Simple device for placement of fertilizer. *Indian Farming*, 2(4) : 27.

APPENDIX IV

Names of crop plants mentioned in the annual report with their botanical names. Alphabetical arrangement has been followed for quick reference.

Arhar	...	...	...	<i>Cajanus cajan</i> (L.) Millsp.
Bajra	...	...	...	<i>Pennisetum typhoides</i> Stapf & Hubbard.
Berseem	...	...	...	<i>Trifolium alexandrinum</i> L.
Bhindi	...	...	...	<i>Abelmoschus esculentus</i> (L.) Moench.
Bottle gourd	...	...	...	<i>Lagenaria siceraria</i> Standley.
Chilli	...	...	...	<i>Capsicum frutescens</i> L.
Cotton	...	...	...	<i>Gossypium</i> sp.
Cowpea	...	...	...	<i>Vigna sinensis</i> Savi.
Drumstick	...	...	...	<i>Moringa oleifera</i> Lam.
Gram	...	...	...	<i>Cicer arietinum</i> L.
Groundnut	...	...	...	<i>Arachis hypogaea</i> L.
Guar	...	...	...	<i>Cyamopsis tetragonoloba</i> (L.) Taub.
Italian millet	...	...	...	<i>Setaria italica</i> Beauv.
Jowar	...	...	...	<i>Sorghum vulgare</i> Pers.
Jute	...	...	...	<i>Corchorus capsularis</i> L. <i>Corchorus olitorius</i> L.
Keshari	...	...	...	<i>Lathyrus sativus</i> L.
Kudzu	...	...	...	<i>Pueraria hirsuta</i> Schneid.
Lentil	...	...	...	<i>Lens culinaris</i> Medic.
Linseed	...	...	...	<i>Linum usitatissimum</i> L.
Maize	...	...	...	<i>Zea mays</i> L.
Mango	...	...	...	<i>Mangifera indica</i> L.
Marua	...	...	...	<i>Eleusine coracana</i> Gaertn.
Methra	...	...	...	<i>Trigonella foenum-graecum</i> L.
Meth	...	...	...	<i>Phaseolus calcaratus</i> Roxb.
Moth	...	...	...	<i>Phaseolus aconitifolius</i> Jacq.
Mung	...	...	...	<i>Phaseolus aureus</i> Roxb.
Oat	...	...	...	<i>Avena sativa</i> L. (The species of oat usually cultivated in India is <i>Avena sterilis</i> L. var. <i>culta</i>).
Paddy	...	...	...	<i>Oryza sativa</i> L.
Papaya	...	...	...	<i>Carica papaya</i> L.
Pea	...	...	...	<i>Pisum sativum</i> L.
Pigeon pea	...	...	...	<i>Cajanus cajan</i> (L.) Millsp.

Pohli	...	...	...	...	<i>Carthamus oxyacantha</i> Beib.
Potato	...	...	...	...	<i>Solanum tuberosum</i> L.
Radish	...	...	...	...	<i>Raphanus sativus</i> L.
Rahar	...	...	...	...	<i>Cajanus cajan</i> (L.) Millsp.
Rape	...	...	...	...	<i>Brassica campestris</i> L. var. <i>toria</i> Duthie & Fuller.
Rice	...	...	...	...	<i>Oryza sativa</i> L.
Safflower	...	...	...	...	<i>Carthamus tinctorius</i> L.
Sannhemp	...	...	...	...	<i>Crotalaria juncea</i> L.
Sarson	...	...	...	...	<i>Brassica campestris</i> L. var. <i>sarson</i> Prain.
Senji	...	...	...	...	<i>Melilotus indica</i> All.
Soyabean	...	...	...	...	<i>Glycine max</i> (L.) Merrill.
Sudan grass	...	...	...	...	<i>Sorghum sudanense</i> Stapf.
Sweat potato	...	...	...	...	<i>Ipomoea batatas</i> Lam.
Tobacco	...	...	...	...	<i>Nicotiana tabacum</i> L.
Tomato	...	...	...	...	<i>Lycopersicon esculentum</i> Mill.
Toria	...	...	...	...	<i>Brassica campestris</i> L. var. <i>toria</i> Duthie & Fuller.
Turnip	...	...	...	...	<i>Brassica rapa</i> L.
Urid	...	...	...	...	<i>Phaseolus mungo</i> L.
Wheat	...	...	...	...	<i>Triticum aestivum</i> L.

